Dispensers

BioJet Quanti ä 3000

AirJet Quanti ä 3000, 2400, 2300

Frontline Quanti ä 1000

Syringe Pump Operating Manual

Revision 1.5

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INTRODUCTION – HOW THIS MANUAL IS ORGANIZED

This manual is both a tutorial and reference guide for the BioJet Quanti™, AirJet Quanti™, Frontline™, and Syringe Pump dispensers. The information is applicable to all BioDot dispensers in any feasible application. This manual is designed to supplement the operating manual for a BioDot system platform, or BioDot in-line production system that contains a dispensing module. If you are not using your dispenser with a BioDot platform, any necessary modifications will have been made at the factory and you should have received any necessary supplementary information. If you find that the information here is insufficient, or not applicable to your particular dispensing application, please contact BioDot Support Services (see Appendix D). The organization style of this manual is similar to that of the BioDot system platform manuals. The information here is organized into chapters, the order of which corresponds to the steps in the basic sequence for the installation, operation, and maintenance of BioDot dispensers. Each chapter contains a sub-section that is specific for each type of dispenser, so that the user may easily access the information specific to their system. **You should read through the sections relevant to your dispenser at least once from beginning to end in order to learn how to properly install, operate, and maintain your dispenser(s) in a safe and efficient manner.** Please refer to the Table of Contents preceding this introduction to locate sections specific to your system.

Chapter Layout

Each chapter of this manual (with the exception of **Chapter One – Dispenser Specifications**, which contains no Procedure section) is organized into two sections, which are outlined below:

Background

The Background section includes a brief introduction to the chapter, followed by a listing of **Key Words** (key terminology defined) and any **Tools and Equipment** you will need for the procedure that follows.
Key Words are italicized the first time they are used in a chapter to indicate that a definition is listed in the Background section.

Procedures

The Procedures section contains step-by-step instructions for the task being performed (Installation, Physical Setup, etc.), and comprises the bulk of each chapter.

Goals, Notes, and Cautions

Throughout the manual, you'll find margin icons or emphasized sections of text designed to draw your attention to key information. The three types of emphasized text found in this manual are Goals, **Notes**: and **Warning**:

Goals: A goal for the information presented is included in the Background section of each chapter, and is emphasized with a margin icon and highlighted text. For example:

F The goal of the background section is to provide you with a context for the information that follows.

Notes: Notes are given throughout the manual. For example:

Note: Notes call your attention to vital information or key instrument features.

Warning: Warnings are in bold text, and are presented in a block format where a potentially hazardous process is described. For example:

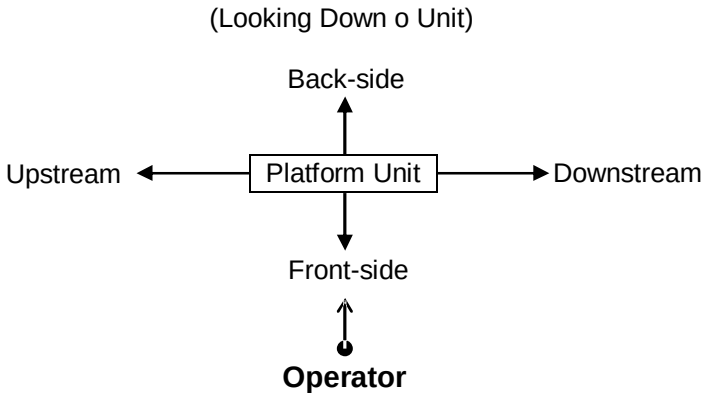
Warning:

Failure to read your manual will greatly impair your ability to operate and maintain your dispenser(s)!

Orienting Terminology

Directional terminology is used throughout the manual to illustrate the relative positions of the system platform components. We have defined this set of terminology below to ensure that these terms are clear to you when you encounter them in your reading:

Note: Except where indicated, directions are given from the point-of-view of a machine operator who is a) facing the front of the machine and b) running web material in the standard direction (from left to right).



Upstream: Refers to elements on the left-hand side, or to the left relative to other elements

Downstream: Refers to elements on the right-hand side, or to the right relative to other elements

Back-side: Refers to elements towards the back of the machine, or away from the operator

Front-side: Refers to elements towards the front of the machine, or nearer the operator

The first chapter of the manual, **Chapter One – Dispenser Specifications**, begins on the following page.

CHAPTER ONE – DISPENSER SPECIFICATIONS

Background

This chapter discusses the specifications, including dispensing parameters and structural components, of each of the BioDot dispensers.

The goal of this section is to provide an overview of the capabilities and structure of each dispenser type; this section will serve as a reference tool for the installation, operation, and maintenance of BioDot dispensers.

Key Words

Drop-on-Demand Technology: Dispensing technology behind the Quanti™ line of dispensers that is based on the combination of a solenoid valve to form drops and a syringe pump to meter reagent; a Quanti dispenser is capable of precisely defined drop sizes or line volumes that are determined by the stepping resolution of the syringe pump and the size of the syringe

Web: The material onto which fluid is dispensed

Line Volume: The volume of reagent contained in a line per unit of length

Line Width: The width, in inches, of a dispensed line; dependent on fluid *rheology* and properties of web material

Repeatability: The degree to which drop volume is conserved between dispensed drops

Rheology: Refers to the flow properties of a dispensed fluid (reagent)

Fluid Path Volume: The volume of reagent within the dispensing system between the syringe pump and the dispenser tip (release point)

Swept Volume: The average volume of reagent that is retained by (lost to) the dispensing system

Volume Recovery (%): The percentage of total reagent that is actually dispensed (total reagent in the dispensing system minus swept volume)

BioJet Quanti Dispensers

This series of quantitative dispensers couples BioDot's *drop-on-demand* valve with one or two high-resolution syringe pumps to meter precise amounts of reagent.

The following syringe pump sizes are available with each of these dispensers: 50 µl, 100 µl, 250 µl, 500 µl, and 1.0 ml

BioJet Quanti 3000 Specifications

Power/Air Requirements

Power is derived from a BioDot dispensing platform (110/220 VAC; 50 – 60 Hz); this dispenser does not utilize air.

Dispensing Parameters

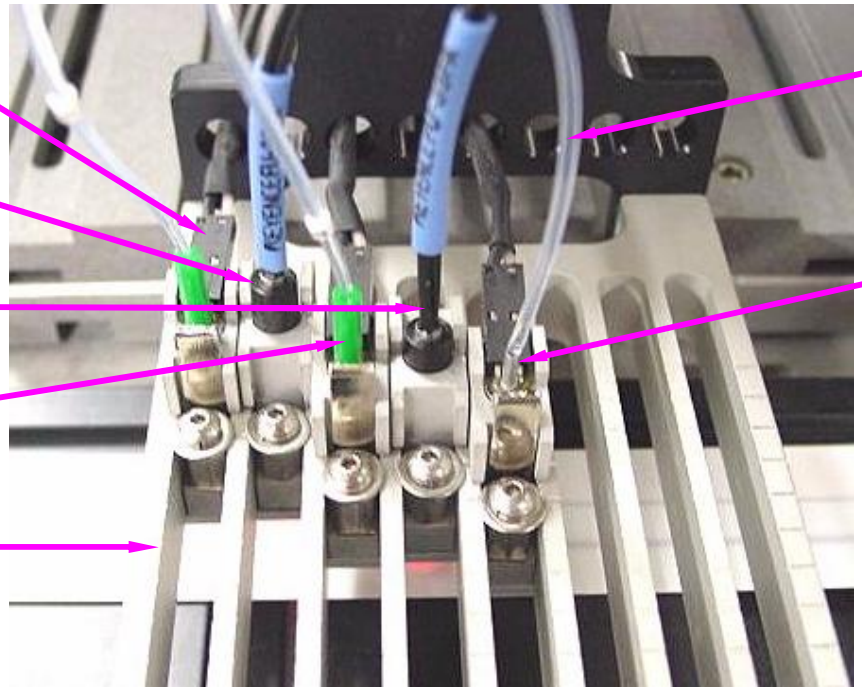
Smallest Drop Volume: 4.2 nl
Drop Size Range: 4.2 nl – 1.0 µl
Volume Range: 0.5 µl – 30 µl/second (dependent on fluid *rheology*)
Smallest Continuous *Line Width*: 0.020 inches (0.5 mm) (dependent on fluid rheology and substrate properties)
Repeatability: ± 1% Line dispensing, and ± 3% Dot-to-Dot dispensing (dependent on fluid rheology and drop size)
Fluid Path Volume: 350 µl (includes feed lines) with a 250 µl syringe at full stroke (depends on how/where lines have been cut)
Volume Recovery: 95%

The BioJet Quanti Dispenser is illustrated on the following page.

The BioJet Quanti Dispenser – Illustrated

Three BioJet Quanti dispensers, with associated components, are shown in **Figure 1**. These figures are representative of the 3000 model, and are shown here in the context of a BioDot system platform with vertical and horizontal positioning stages. Please take a moment to familiarize yourself with the basic layout of the dispenser, before proceeding to **Chapter Two – Dispenser Installation**:

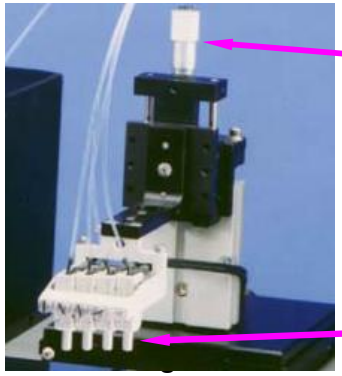
Note: The barbed inlet port may have a BioJet Plus™ fitting instead. The supply line will have to have a matching fitting.



*Line Presence Inspection System (Optional Component; see App C)

BioJet Plus ä Fitting

Barbed Fitting



AirJet Quanti Dispensers

This series of dispensers couples aerosol spray airstream technology with one or two syringe pumps to meter precise amounts of reagent.

The following syringe pump sizes are available: 50 µl, 100 µl, 250 µl, 500 µl, and 1.0 ml

Note: A **crown tip** is supplied in the toolkit that comes with each AirJet. The crown tip is an alternative tip that should be used when dispensing very close to the web material (when a finer line is required). Refer to **Figure 2**.

AirJet Quanti 3000 Specifications

The AirJet Quanti 3000 is the smallest aerosol dispenser in this series, with a nozzle/needle size of 0.30 mm.

Power/Air Requirements

Power is derived from a BioDot dispensing platform (110/220 VAC; 50 – 60 Hz).

Air source required: 10 - 40 PSIG (0.70 - 2.80 Kg/cm^2); ***it must be a clean, dry, and filtered air source at constant pressure.***

Dispensing Parameters

Dispensing Range: 1 µl/cm - 22 µl/cm (dependent on fluid rheology)

Line Width Range: 0.02 inches (0.5 mm) to 0.24 inches (6 mm) (line width is highly dependent on fluid rheology and substrate properties)

Repeatability: ± 1% Line dispensing

Swept (Dead) *Volume*: approximately 1.5 µl

AirJet Quanti 2300 Specifications

The AirJet Quanti 2300 is the second largest aerosol dispenser in this series, with a nozzle/needle size of 0.60 mm.

Power/Air Requirements

Power is derived from a BioDot dispensing platform (110/220 VAC; 50 – 60 Hz).

Air source required: 10 - 40 PSIG (0.70 - 2.80 Kg/cm^2); ***it must be a clean, dry, and filtered air source at constant pressure.***

Dispensing Parameters

Dispensing Range: 1 µl/cm - <80 µl/cm (dependent on fluid rheology)

Line Width Range: 0.04 inches (2.0 mm) to 0.60 inches (15.0 mm) (line width is highly dependent on fluid rheology and substrate properties)

Repeatability: ± 1% Line dispensing

Swept (Dead) Volume: approximately 1.8 µl

Volume Recovery: <98%

AirJet Quanti 2400 Specifications

The AirJet Quanti 2400 is the largest aerosol dispenser in this series, with a nozzle/needle size of 0.80 mm.

Power/Air Requirements

Power is derived from a BioDot dispensing platform (110/220 VAC; 50 – 60 Hz).

Air source required: 10 - 40 PSIG (0.70 - 2.80 Kg/cm^2); ***it must be a clean, dry, and filtered air source at constant pressure.***

Dispensing Parameters

Dispensing Range: 1 µl/cm - 30 µl/cm (dependent on fluid rheology)

Line Width Range: 0.08 inches (2.0 mm) to 1.00 inches (25.0 mm) (line width is highly dependent on fluid rheology and substrate properties)

Repeatability: ± 1% Line dispensing

Swept (Dead) Volume: approximately 1.8 µl

Volume Recovery: <98%

The AirJet Quanti Dispenser – Illustrated

The AirJet Quanti dispenser, with associated components, is shown in **Figure 2**. These figures are representative of the 3000, 2400, and 2300 models. The AirJet is shown here in the context of a BioDot system platform with vertical and horizontal positioning stages. Please take a moment to familiarize yourself with the basic layout of the dispenser, before proceeding to **Chapter Two – Dispenser Installation**:

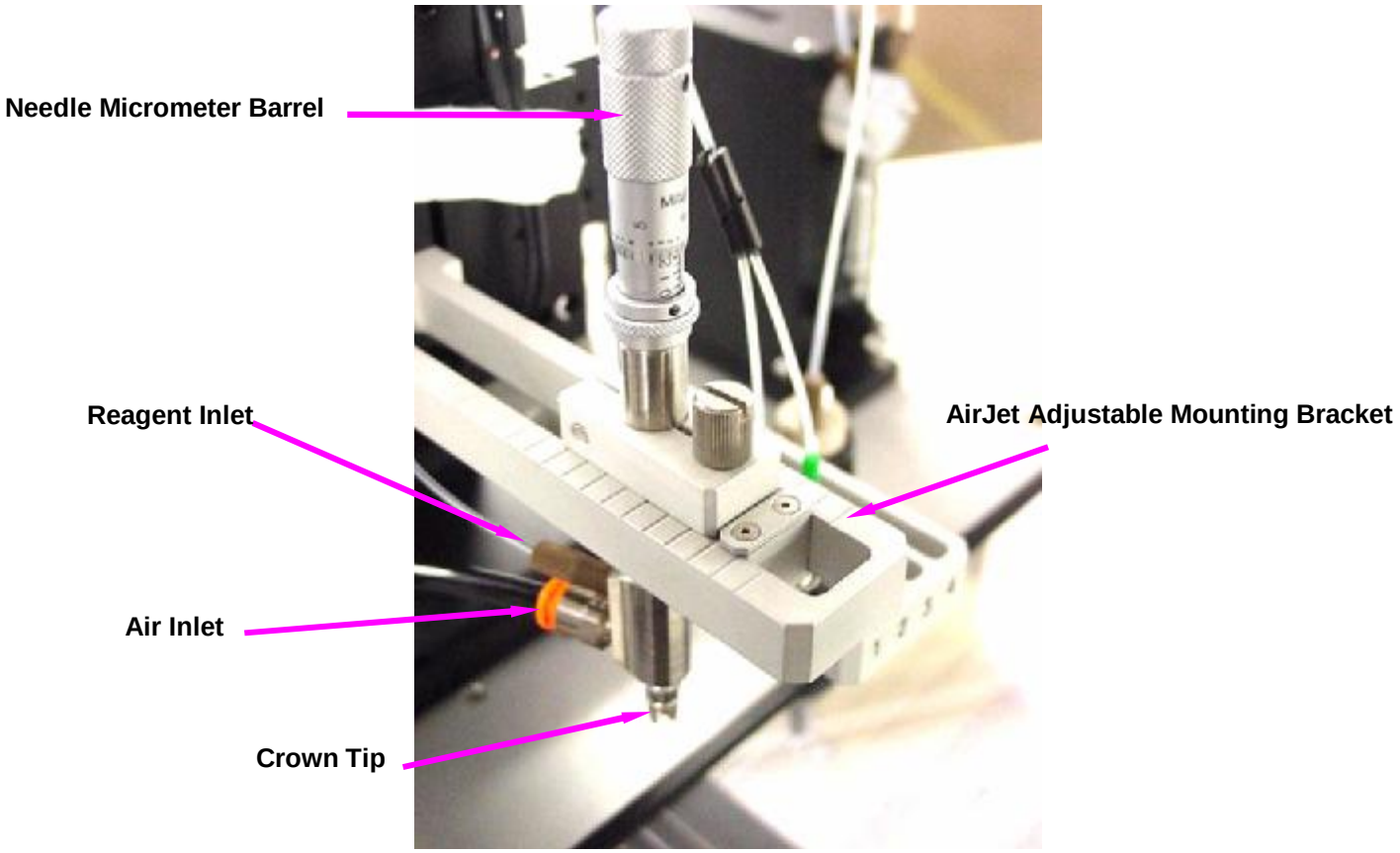


Figure 2

Frontline Quanti 1000 Dispenser

This dispenser couples a micro-tube dispenser with one or two syringe pumps (based on dispensing rate) to meter precise amounts of reagent or ink.

The following syringe sizes are available: 50µl, 100µl, 250µl, 500µl, and 1.0ml

Power/Air Requirements

Power is derived from a BioDot dispensing platform (110/220 VAC; 50 – 60 Hz); this dispenser does not utilize air.

Dispensing Parameters

Minimum Dispense Volume: 0.1 µl/second (dependent on fluid rheology)

Minimum Continuous Line Width: 0.3 mm (line width is highly dependent on fluid rheology and substrate properties)

Maximum Fluid Path Volume: < 350 µl (using a 250 µl syringe and 20 cm of standard tubing)

Repeatability: ± 1% (dependent on fluid rheology)

Volume Recovery: 95%

The Frontline Quanti Dispenser – Illustrated

The Frontline Quanti dispenser is shown in **Figure 3**. Please take a moment to familiarize yourself with the basic layout of the dispenser, before proceeding to **Chapter Two – Dispenser Installation**:

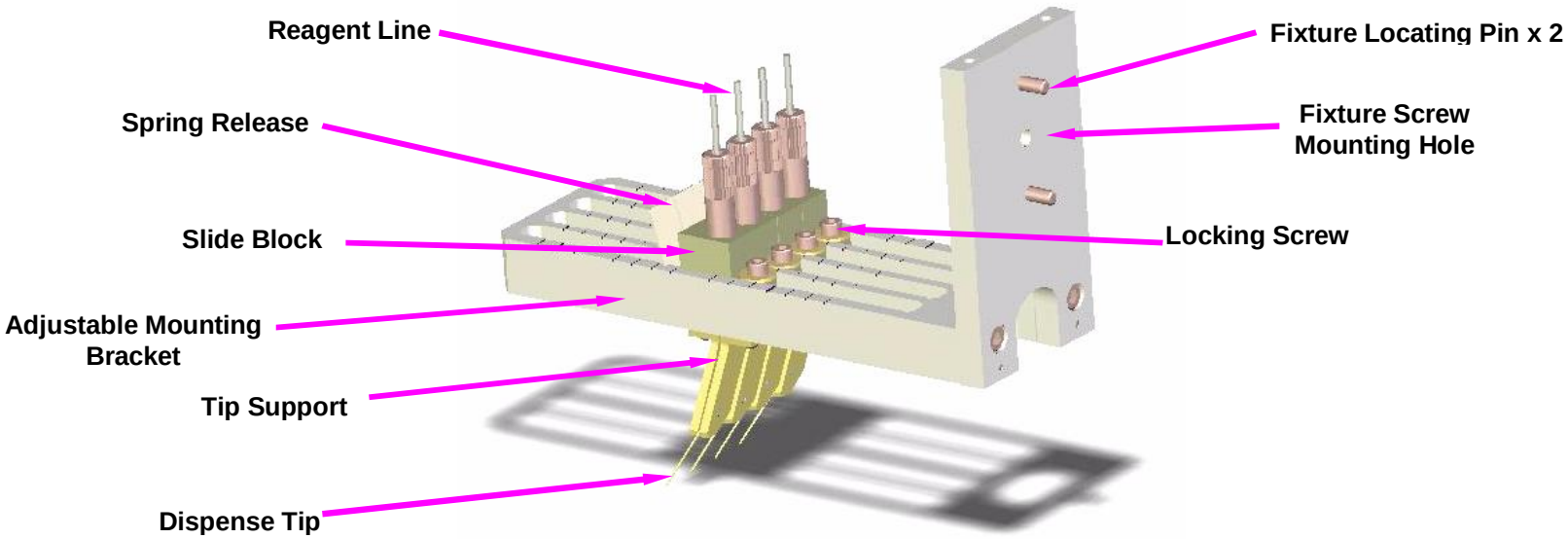


Figure 3

Syringe Pump Dispenser

The Syringe Pump Dispenser is the driving force behind BioJet, Airjet or Frontline Quanti Dispensers, though it may be used on its own to dispense precise amounts of fluid. The syringe pump dispenser utilizes a positive displacement pump, a programmable stepper motor and a syringe.

The following syringe sizes are available: 50 µl, 100 µl, 250 µl, 500 µl, and 1.0 ml

Power/Air Requirements

Power is derived from a BioDot dispensing platform (110/220 VAC; 50 – 60 Hz); this dispenser does not utilize air.

Dispensing Parameters

Pump literature is provided with the unit.

The Syringe Pump Dispenser – Illustrated

A pair of syringe pump dispensers, with associated components, is shown in **Figure 4** below. Please take a moment to familiarize yourself with the basic layout of the dispenser, before proceeding to **Chapter Two – Dispenser Installation**:

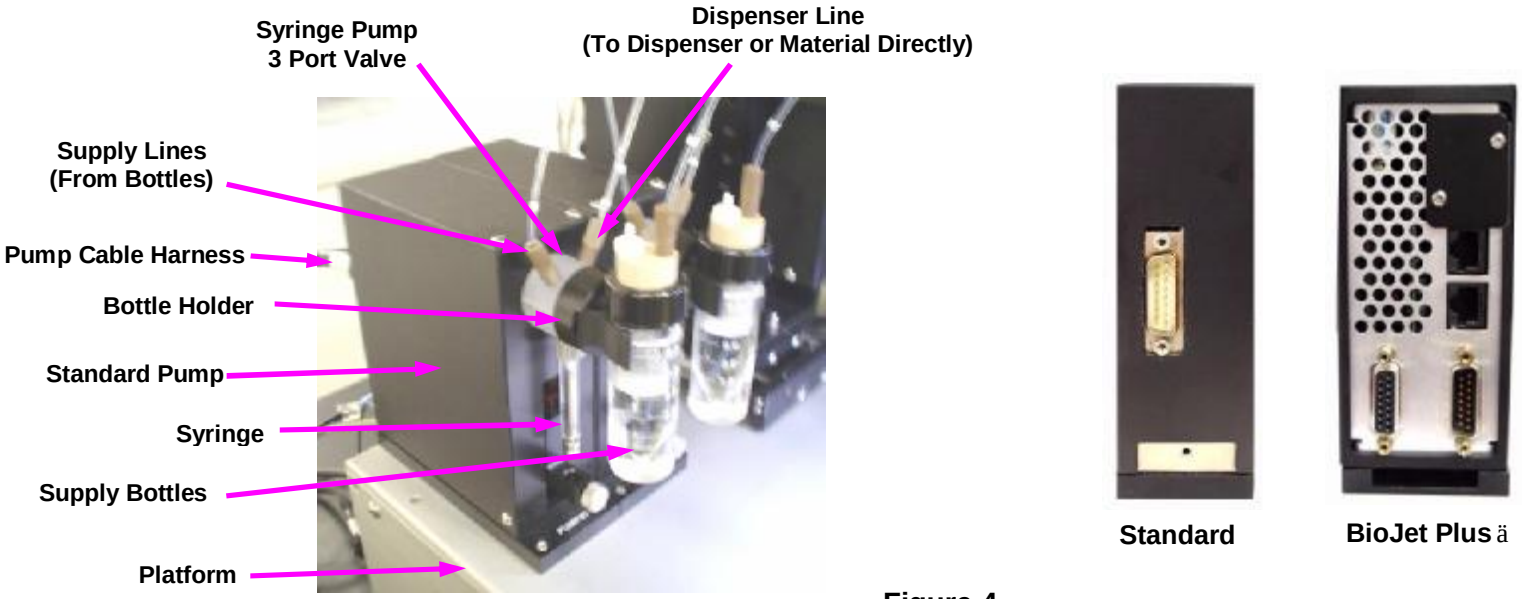


Figure 4

CHAPTER TWO - DISPENSER INSTALLATION

Background

BioDot dispensers are designed to install quickly and easily, and few with tools required. As we mentioned in the introduction to this manual, the instructions given assume installation onto a BioDot *system platform*. If you find that the information here is insufficient or not applicable to your particular dispensing application, please contact BioDot **Support Service** (see Appendix D).

F The goal of this section is to outline the steps in the installation of all models of BioDot dispensers.

Key Words

System Platform: Refers to the machine used for reagent application that incorporates a BioDot dispenser (i.e. XYZ 3000, RR4500 Web Handling System, etc.).

Dispensing Platform: The mounting surface for the attachment of dispensers; the position of the dispensing platform is adjustable in the X and Y-axis.

Supply Bottle: The reservoir that holds the supply reagent.

Reagent Supply Line: Teflon tubing used to carry reagent from the supply bottle to the syringe pump and/or dispenser, or directly to the web.

Support Arm: A universal mounting bracket that a dispenser, via a smaller mounting bracket, is mounted to; the support arm attaches in some platform systems to a vertical and/or horizontal positioning stage.

BNC: Also Bayonet or Coaxial connectors, a BNC connector is used to interface BioJet dispensers with the system platform.

Vertical (Z-Axis) Positioning Stage: Also called the “Z-Slide.” An integrated dispensing component of certain BioDot dispensing platforms that is height-adjustable (Z axis) through the use of a micrometer; a dispenser is mounted to the vertical positioning stage via a support arm.

Horizontal (Y-Axis) Positioning Stage: An integrated dispensing component of certain BioDot dispensing platforms that is height-adjustable, in the y-axis, through the use of a micrometer; a dispenser and associated components are mounted to the horizontal positioning stage via a universal mounting bracket.

Line Presence Inspection System: An optional dispensing system component, consisting of fiber-optic sensors that detect the presence/absence of a dispensed line; absence of a line is signaled and triggers the placement of an ink line on the web material (see **Line Presence Inspection System** in Appendix B, for more details).

Inlet Port: A point on the dispenser where a reagent feed line attaches. This port may be attached to the reagent line via a plastic fitting and ferrule, barbed fitting and sleeve collar or screw in plastic fitting.

Quick Connect Fitting: This fitting is used to make the airtight airline connection on a BioDot AirJet.

HPLC Fitting: The ferrule and nut style fitting used to make the watertight reagent supply line connection on the AirJet

AMP: An AMP (brand-name) connector is a larger, round (usually black), panel pin-and-socket connector (interfaces with a jack on the back of the unit).

Cable Assembly: The grouping of cables factory-assembled to assure proper connection between the syringe pumps, and between the syringe pumps and the system platform. The cable assembly connector is the connection head that attaches to the syringe pump 15-pin connector.

Tools/Equipment

- Set of Allen wrenches (provided with the platform system).

Procedures

BioJet Quanti 3000 Installation

Unpacking

1. Remove the BioJet(s), support arm, and reagent supply lines from the packing container; carefully remove from inner wrapping material.
2. Locate the packing checklist that is provided with the instrument. Please go over this list to confirm that all ordered parts, tools and accessories are accounted for. If an item is missing, please see **Support Service**, in Appendix D of this manual.

Note: BioJet dispensers are fully assembled on arrival, and attached to a small mounting bracket by which it is mounted to the support arm.

Please refer to the Dispenser Specifications section if you would like information on basic construction of the BioJet Quanti. Please DO NOT attempt to take a dispenser apart without first contacting BioDot Support Service. Attempting to disassemble a dispenser could damage the instrument and will void your product warranty.

Installation

The following installation instructions apply to both the 3000 model BioJet.

1. Ensure platform power is **OFF**.
2. Install the Syringe Pump (see **Syringe Pump Installation**).
3. Attach the BioJet support arm to the Vertical Positioning Platform (in some systems the support arm will be attached to the system platform at the factory and may attach and look differently) using the supplied hardware. (See **Figure 5**).
4. Mount the BioJet Quanti Dispenser(s) (via the small mounting bracket) to the support arm using the supplied hardware (see **Figure 5**).
5. Obtain the coaxial cable(s) provided for dispenser hook-up. (Standard pumps)
6. Connect the coaxial cable to the BNC connector marked BioJet #1 (see **Figure 6**):
   - Push the cable connector onto the BNC connector to engage.
   - Turn the cable connector ¼ turn clockwise to lock the connection in place.
   - Repeat for additional BioJets.

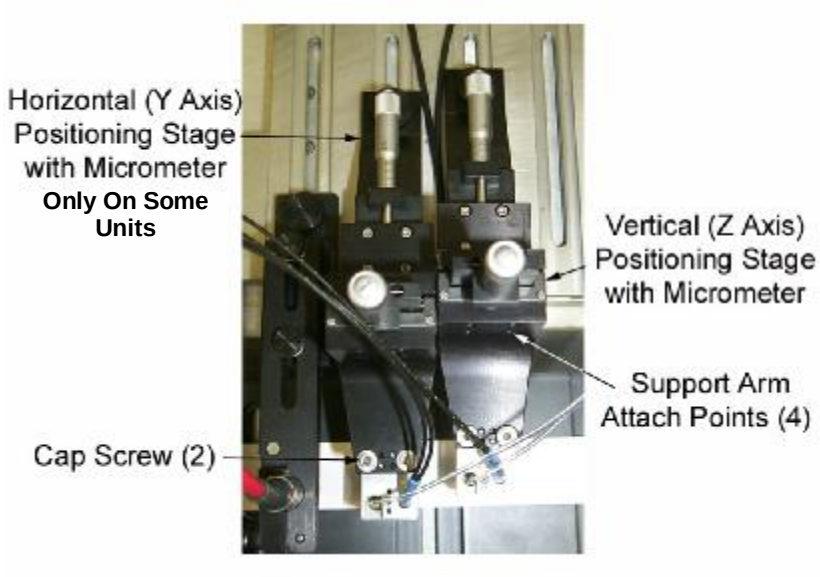

Horizontal (Y Axis) Positioning Stage with Micrometer
Only On Some Units
Vertical (Z Axis) Positioning Stage with Micrometer
Support Arm Attach Points (4)
Cap Screw (2)

Figure 5

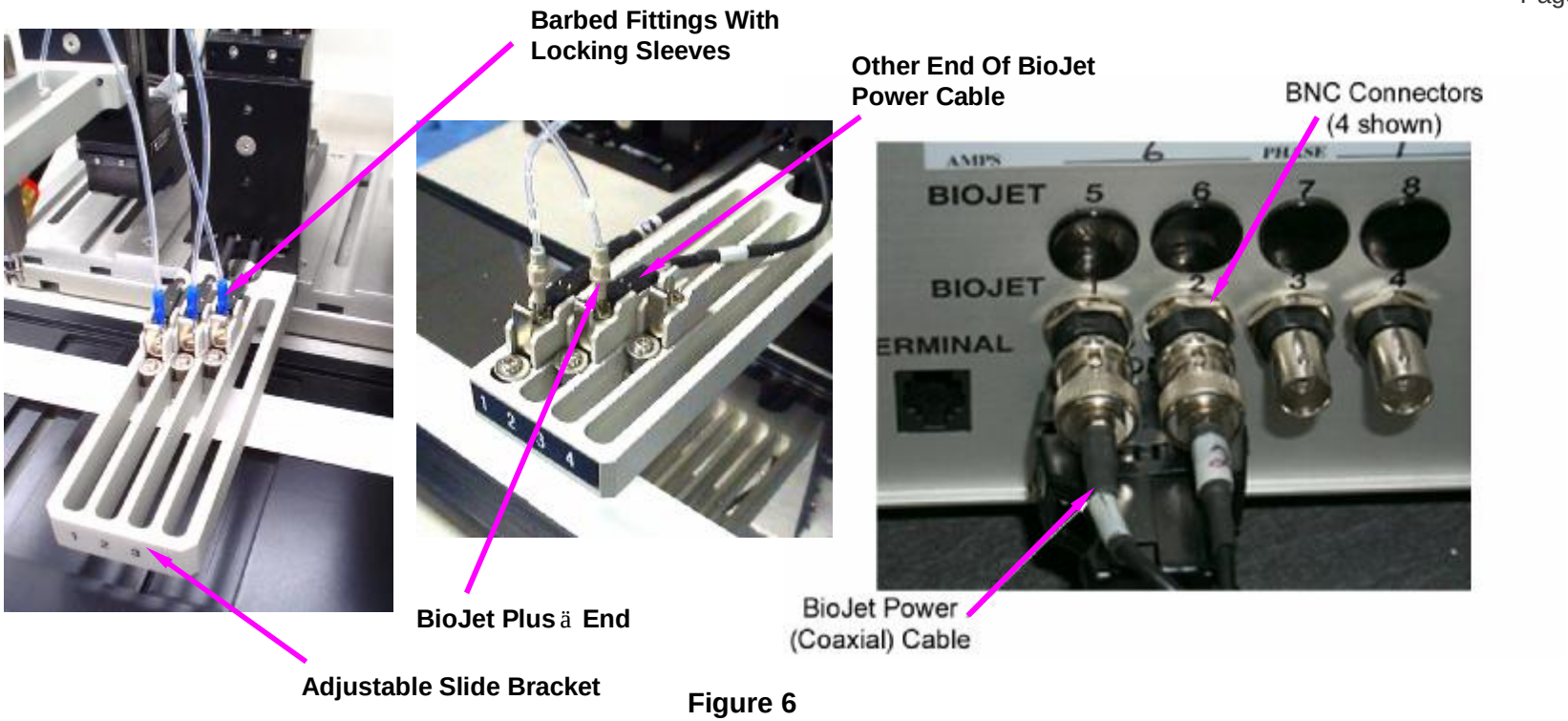


Figure 6

Note: Where multiple dispensers are installed, the first dispenser must be connected to the connector labeled BioJet #1, the second one to BioJet #2, etc. Their order (BioJet #1, BioJet #2, etc) corresponds to their position on the platform from left to right (where the user is facing the front side of the unit). Do not skip any connectors.

7. Connect the opposite end of the cable to the BioJet, by pushing the cable connector onto the exposed pins on the back of the dispenser (without regard to connector orientation).
8. Connect the free end of the reagent supply line from the syringe pump to the BioJet inlet port. This may be a bore end or a BioJet Plus™ end. Refer to **Figure 1**. Insert the bore end over the barbed fitting and slide the green locking sleeve over the connection. If it is a BioJet Plus™ fitting screw the fitting into the top of the BioJet valve and tighten.
9. Restore power, and test dispenser (see **BioJet Quanti 3000 Operation** in Chapter Three).

Note: If your system includes a Line Presence Inspection System, you will need to install the fiber optic wires for this system. See **Line Presence Inspection System** in Appendix C for information on installation of this optional system.

AirJet Quanti 3000, 2300 and 2400 Installation

Unpacking

1. Remove the AirJet(s) and air and reagent supply lines from the packing container; carefully remove all components from inner wrapping material.
2. Locate the packing checklist that is provided with the instrument. Please go over this list to confirm that all ordered parts, tools and accessories are accounted for. If an item is missing, please see **Support Service** in Appendix D of this manual.

Note: AirJet dispensers are fully assembled on arrival. Please refer to **Figure 2** in **Chapter One – Dispenser Specifications** if you would like information on basic construction of AirJet Dispensers.

Warning:

Please DO NOT attempt to take an AirJet apart without first contacting BioDot Support Service. Attempting to disassemble a dispenser could damage the instrument and will void your product warranty.

Installation

The following installation instructions apply to the 3000, 2400 and 2300 models of AirJet Dispensers.

1. Ensure platform power and air pressure are off.
2. Install the Syringe Pump (see **Syringe Pump Installation**).
3. Attach the support arm assembly (AirJet mounting bracket attached) to the dispensing platform using the four No. 6-32 x ½ inch long socket head cap screws provided, if necessary (it is usually already mounted on the platform).
4. Secure the AirJet inside the mounting bracket:
5. Position the AirJet inside the split-clamp, with the air and reagent line inlet ports facing back
6. Tighten the split-clamp knob to secure the AirJet
7. Attach the supplied air line to the air inlet port (lowermost port) in the lower back portion of the AirJet by screwing the ¼ inch *quick connect fitting* to the AirJet air inlet port (see **Figure 7**).
8. Attach the other end of the airline to the mating receptacle labeled AIRJET or DISP *n* (where *n* is the AirJet number from left to right where 1 or more AirJet dispensers are installed) on the system platform rear panel. Insert the fitting into the air outlet receptacle and twist clockwise to lock in place (see **Figure 7**).

Note: There may be slight differences between system platforms in the label assigned to the AirJet air outlet receptacle.

9. Attach the reagent supply line, via the ¼-28 *HPLC fitting* provided, to the supply line inlet port (uppermost port) in the lower back portion of the AirJet (see **Figure 7**).

10. Locate the AirJet air pressure gauge on the front of the system platform-dispensing module. Lower AirJet air pressure gauge to a minimal pressure before AirJet operation. Turn the knob counter-clockwise to lower the pressure to an appropriate operation level (per your dispensing application).

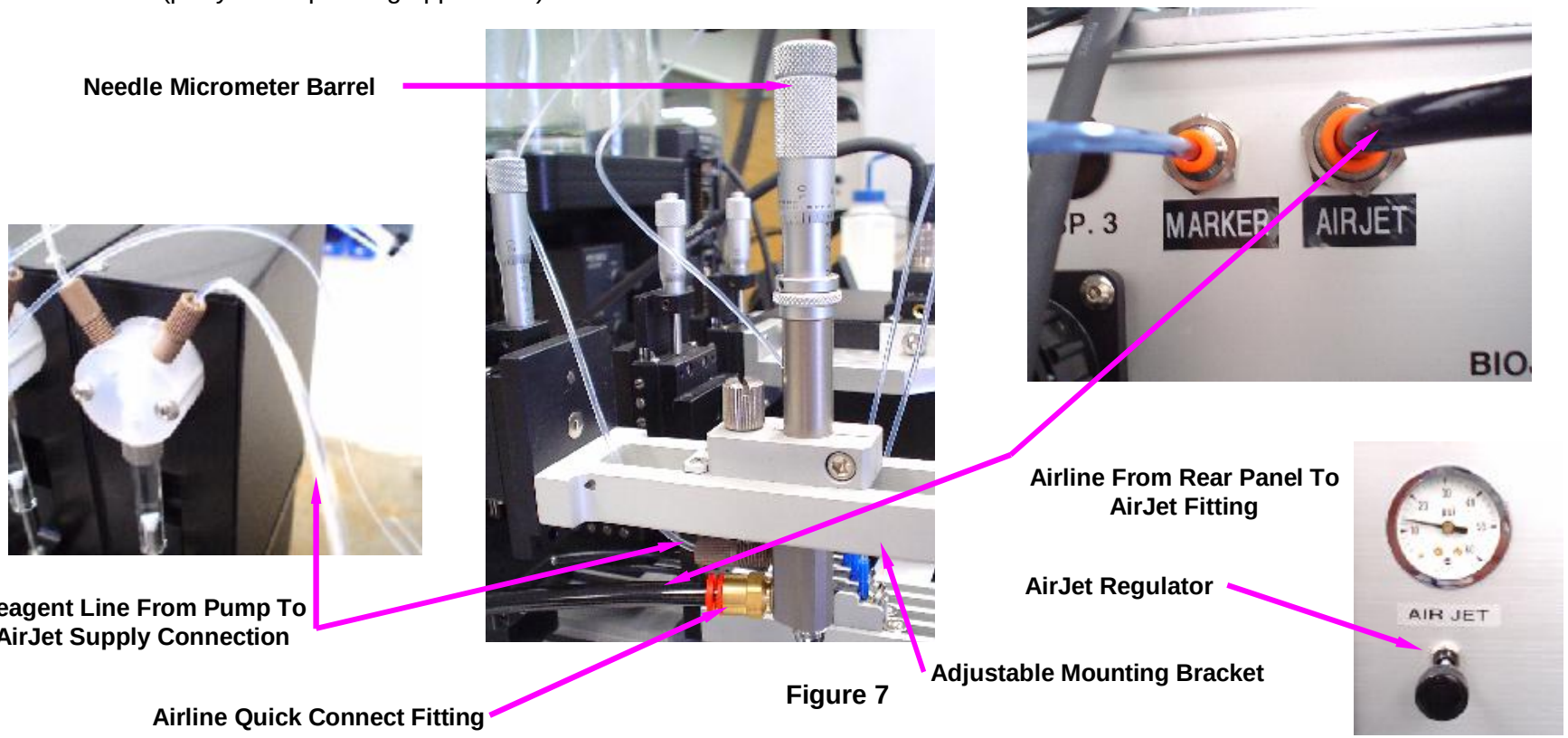


Figure 7

Warning:

The adjustment knobs of the front panel air regulators are fully inserted, at the maximum pressure setting, prior to shipment to prevent damage to the knobs. The gauge pressure should be lowered to a minimal pressure before air pressure is applied to the unit.

11. Restore power and air pressure and test the AirJet (see **Chapter Three – Dispenser Operation** for dispensing instructions).

Note: We have not included specific testing protocols for the AirJet dispenser, as it is (compared to the BioJet) a far less complex dispenser to set up and use. See the Airjet troubleshooting guide if problems arise.

Frontline Dispenser Installation

Unpacking

1. Remove the dispenser(s) from the packing container, and carefully remove the dispenser from its plastic wrapping. **Note**: The dispensers may be already attached to the head assembly. Remove the head assembly from the protective box and install on the platform with the supplied hardware.

Warning:

Frontline Dispenser tips are fragile and should be handled with care.

2. Locate the packing checklist that is provided with the instrument. Please go over this list to confirm that all ordered parts, tools and accessories are accounted for. If an item is missing, please see **Support Service** in Appendix D of this manual.

Installation

The frontline dispenser is very easy to set up and use. The dispenser simply attaches to the vertical positioning stage, and is secured by a screw. Adjust the position of the dispenser, as described below: **Note**: The Frontline dispenser may be facing in either direction depending on the application and platform it is being used on.

1. Ensure system power is **OFF**.
2. Install the Syringe Pump (see Syringe Pump Installation).
3. Secure support arm attach plate to vertical positioning stage using the supplied hardware. Refer to **Figure 8**.
4. Loosen the locking screw, depress the spring lock and slide the dispenser to the desired location. Release the spring lock and secure the position with the locking screw.
5. Screw the supply line tubing assembly(s) from the syringe pump into inlet ports on the downstream side of the dispenser.
6. Restore power and test dispenser (see Chapter Three – Dispenser Operation for dispensing instructions).

Note: We have not included specific testing protocols for the Frontline dispenser, as it is (compared to the BioJet) a far less complex dispenser to set up and use. If problems arise, perform the appropriate Weekly Cleaning and Decontamination Procedure in **Chapter 4 – Cleaning and Maintenance of Dispensers**, and/or contact BioDot Support Service.

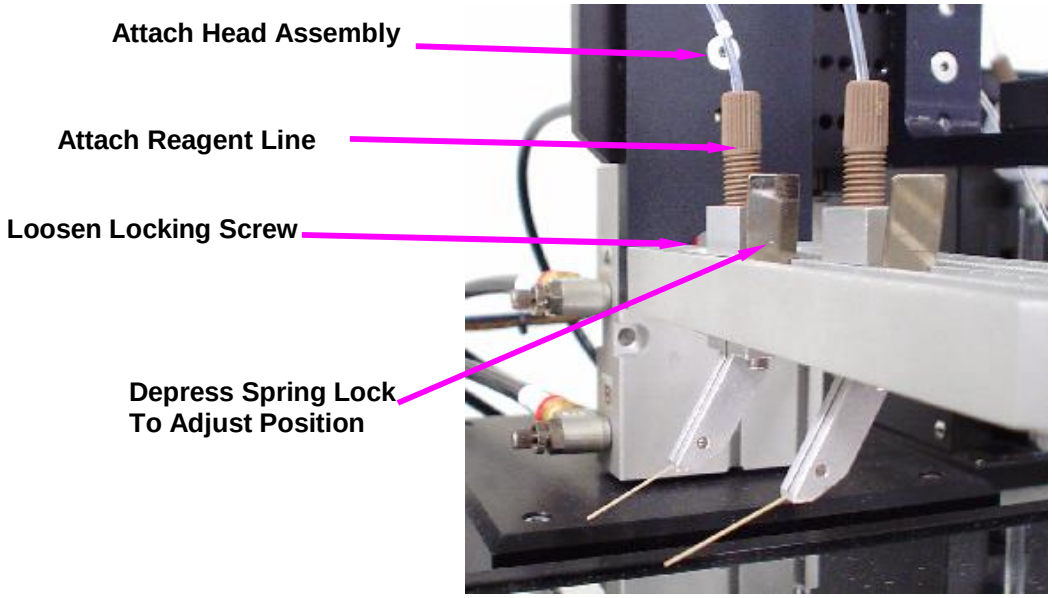


Figure 8

Syringe Pump Installation

Unpacking

1. Remove the syringe pump(s) from the packing container, and carefully remove from the plastic wrapping.
2. Locate the packing checklist that is provided with the instrument. Please go over this list to confirm that all ordered parts, tools and accessories are accounted for. If an item is missing, please see Support Service, in Appendix D of this manual.

Note: Syringe Pumps are fully assembled on arrival and may already be attached to the platform depending on the unit. Please refer to **Figure 9**. Refer to **Figure 4** for pump definition. You may need to remove the blue pump valve cover and attach the bottle clip with the supplied hardware.

Warning:

Please DO NOT attempt to take a Syringe Pump apart without first contacting BioDot Support Service. DO NOT remove any cable with the power ON. Attempting to disassemble a dispenser could damage the instrument and will void your product warranty.

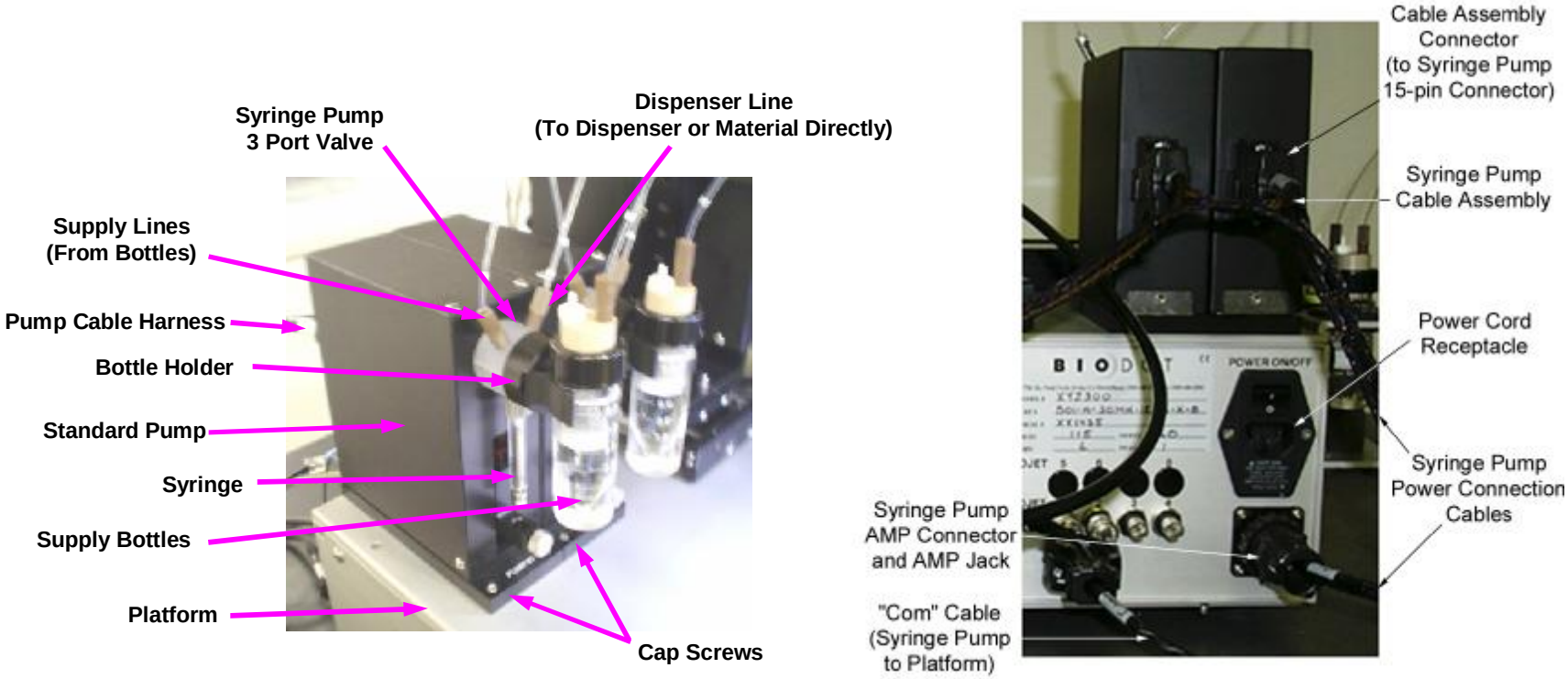


Figure 9

Installation

The syringe pumps require proper connection to the system platform central processing unit (CPU), via the *cable assembly* "COM" line or harness; proper connection to system platform power via the cable assembly AMP connector; and proper connection to each other via the cable assembly connectors (one for each standard pump). Please refer to **Figure 9** while going through the installation procedure. **Note**: If you are installing BioJet Plus™ pumps, please refer to the BioDot OEM pump manual for details.

1. If pumps require mounting: Locate the two pre-drilled attach points for the syringe pump(s) on your system platform (XYZ or ZX platform) or pump platform (Reel-to-Reel platform).
2. Attach the syringe pump(s) to the system platform or pump platform using the two No. 6-32 x ½ inch long socket head cap screws provided.
3. Once pumps are mounted to platform: Connect the cable assembly connector to the syringe pumps rear 15-pin connector (standard pump). Secure the connector with the screws in the connector housing. Repeat this process for all of the syringe pumps.
4. Connect the 9-pin serial interface cable labeled “COM” from the cable assembly to the platform connector labeled “COM”.
5. Locate the AMP connector for the syringe pump(s). Insert the connector into the corresponding connection on the rear of the module. J1 – J1, etc.

Note: There may be some variation in labeling of plugs and jacks; see also system platform manual for further details.

6. Fit a syringe of appropriate size to the pump:
   - Insert plunger all the way inside the syringe barrel prior to installation.
   - Screw the syringe barrel into the receptacle in the pump valve assembly.
   - Loosen the plunger thumbscrew on the base of the syringe plunger arm. Slide the syringe plunger out of the syringe barrel by pushing gently downwards on the plunger arm, and position the bottom end of the plunger in the plunger arm receptacle.
   - Re-tighten the plunger arm thumbscrew to secure syringe.
7. Attach supply line tubing to the syringe pump:
   - Feed supply line tubing into the supply reagent bottle via the HPLC connector provided, and secure the lid in place; attach the other end of the supply line to the left-hand port of the 3 port valve on the syringe pump via the HPLC connector provided.
   - Screw the BioJet Plus™ dispense line into the output (dispense) side of the syringe pump 3 port valve assembly. Right hand port.
   - With Quanti dispensers: Attach the other end of the dispenser line to the dispenser as discussed in the Dispenser Installation section.
   - If dispensing with Syringe Pump only: Attach an appropriate tip to the end of the supply line for direct dispensing per your application.
8. Restore power and test Syringe Pump (see syringe pump operation).

Note: We have not included specific testing protocols for the Syringe Pump, as it is (compared to the BioJet) a far less complex dispenser to set up and use. If problems arise, please refer to the product literature from Cavro Scientific Instruments, Inc. or contact BioDot Support Service.

CHAPTER THREE - DISPENSER OPERATION

Background

In this chapter you will learn how to design, input, and store dispensing programs for BioDot system platforms using the hand-held terminal. For the sake of continuity, we will focus on the programming capabilities of the hand-held terminal *relevant to the dispensers*; a more in-depth discussion of platform configuration with the hand-held terminal can be found in the system platform manual.

We suggest that you go through this section of the manual with the hand-held terminal in hand. This is useful for two reasons: First, it will help you become familiar/comfortable with the terminal itself. Second, as there are some differences in the menu structure between platforms, you might find it useful to note specifics of your menu programming in the manual as you go along.

The goal of this chapter is to instruct you in **Running a Dispense Cycle** and **Inputting Programs** with the platform hand-held terminal, and to explain the operational aspects of the individual dispenser types that impact the design of dispensing patterns.

Key Words

LCD/Screen/Display: The Liquid Crystal Display (LCD) is the 4-line screen located on the hand-held terminal.

Non-volatile Memory: Non-volatile Memory is memory that keeps its data when power is lost to the unit. Non-volatile memory is used for long-term storage of data.

Working Memory: Working Memory is used to create or modify data. Data in working memory are lost when the unit is powered down unless saved under the DATA STORAGE menu.

Program: A program is a storage location, in *non-volatile memory*, for a set of patterns that comprise a web-handling process.

Pattern: The word pattern signifies a programmed series of dispensing actions, which is part of a dispensing program. The menu title PATTERN (found in XYZ/ZX platform software) is used interchangeably with the PROGRAM menu title (found in Reel-to-Reel platform software), in that they are both used in the creation or editing of programs.

Keypad: The Keypad is the set of buttons on the hand-held terminal.

Menu: A Menu is a specific grouping of information and fields. One menu at a time can be displayed. Menus that are longer than 4 lines are partially displayed on the LCD. The hidden part of the menu can be displayed by scrolling the text up or down with the arrow keys.

Menu Structure: The menus are arranged in a hierarchical (tree) structure. The highest level is called the main menu. From this menu you can access only sub-menus at different levels in the hierarchy; the ESC key is used to return to the previous (higher level) menu.

Field: Fields are the areas within each line of a menu where data can be entered.

Menu Selector: The Menu Selector is the indicator arrow (>) that points to the active menu element.

Edit Field: An Edit Field is a field that contains an editable numeric or textual value after the field name (i.e. LENGTH: 200 or NAME: MYPROGRAM). A new value is entered into an edit field by selecting the field with the Up ↑ or Down ↓ arrow keys and then typing the new value using the keypad.

Toggle Field: A Toggle Field is similar to an edit field, except that the associated data are selected from a fixed group of choices. A new choice is selected by using the Up/Down arrow keys to move the menu selector to the field to be changed.

Activated: This term describes a toggle field, which is set to YES or ON.

Pitch: The drop pitch describes the distance (in millimeters) between drop centers.

Rate: The dispense rate is the volume of reagent dispensed per centimeter in a dispensing program, expressed in ul/cm.

Drop Volume: The drop volume is the volume of each drop dispensed, expressed in nl.

On Time: The on time is the length of time (in milliseconds) that a dispenser valve stays open during each unit of a dispensing sequence.

Procedures

Running a Dispense Cycle

The dispense cycle begins and ends with the hand-held terminal. Data are entered via the keypad; the menu structure, stored data and unit status are displayed on the *LCD*. Please refer to your user manual for a full description of the keypad.

Navigating the Menus

Four keys are used to move through the menu hierarchy:

- The UP ↑ and DOWN ↓arrow keys move the menu selector up or down one line. The entire menu will scroll upward or downward if the selector is already at its top or bottom position and there are additional menu items above or below the currently selected one.

Note: The RIGHT → and LEFT ← arrow keys are not used.

- The ENTER key will activate the currently selected menu item, and either bring up a sub-menu, or toggle between fields in a toggle field.
- The ESC key displays the menu above the current one in the hierarchical structure. Pressing ESC will ultimately bring the operator to the Main Menu.

Starting a Cycle

The dispense cycle, once programmed into working memory, is executed by pressing the GO key on the hand held terminal. The platform will sequentially scan each of the patterns in working memory in order and dispense each selected pattern. If pattern repeat is in use (see REPEAT in **EDIT Sub-Menu Options - Defined** later in this chapter), the platform will move to each grid element and dispense all enabled tasks.

Aborting A Cycle

A dispense cycle may be interrupted at any point by pressing the ABORT key on the hand held terminal. Any dispensing activity will immediately cease and the slides will be returned to the park position.

Alternatively, the operator may use the PAUSE MODE key, which allows the operator to pause the platform either before or right after the dispense sequence. The operator can then press GO to resume or ABORT to stop.

Note: Using the PAUSE key to pause the platform is useful in confirming dispenser positioning after programming.

Dispenser Errors

When the platform detects an error condition, it will pause to display the errors to the operator for corrective action. The operator must acknowledge the error by pressing the ENTER key. If the error occurred during a dispense cycle, the cycle will be aborted and the slides retracted to the park position.

Inputting Programs

Menu Hierarchies

In this section, we have provided a representation of the menu hierarchies within the hand-held terminal software menus *that pertain specifically to the dispensers*. For the sake of economy, we have omitted all fields that do not pertain to the dispensing cycle. We will refer to this hierarchy throughout the chapter; please refer to your system platform manual for information on platform-specific fields. For a complete description of the hand-held terminal and menu hierarchies, please refer to the user manual.

There are six levels total in the hierarchy (the main menu and five sub-menus). The top level represents the Hand-held terminal main menu:

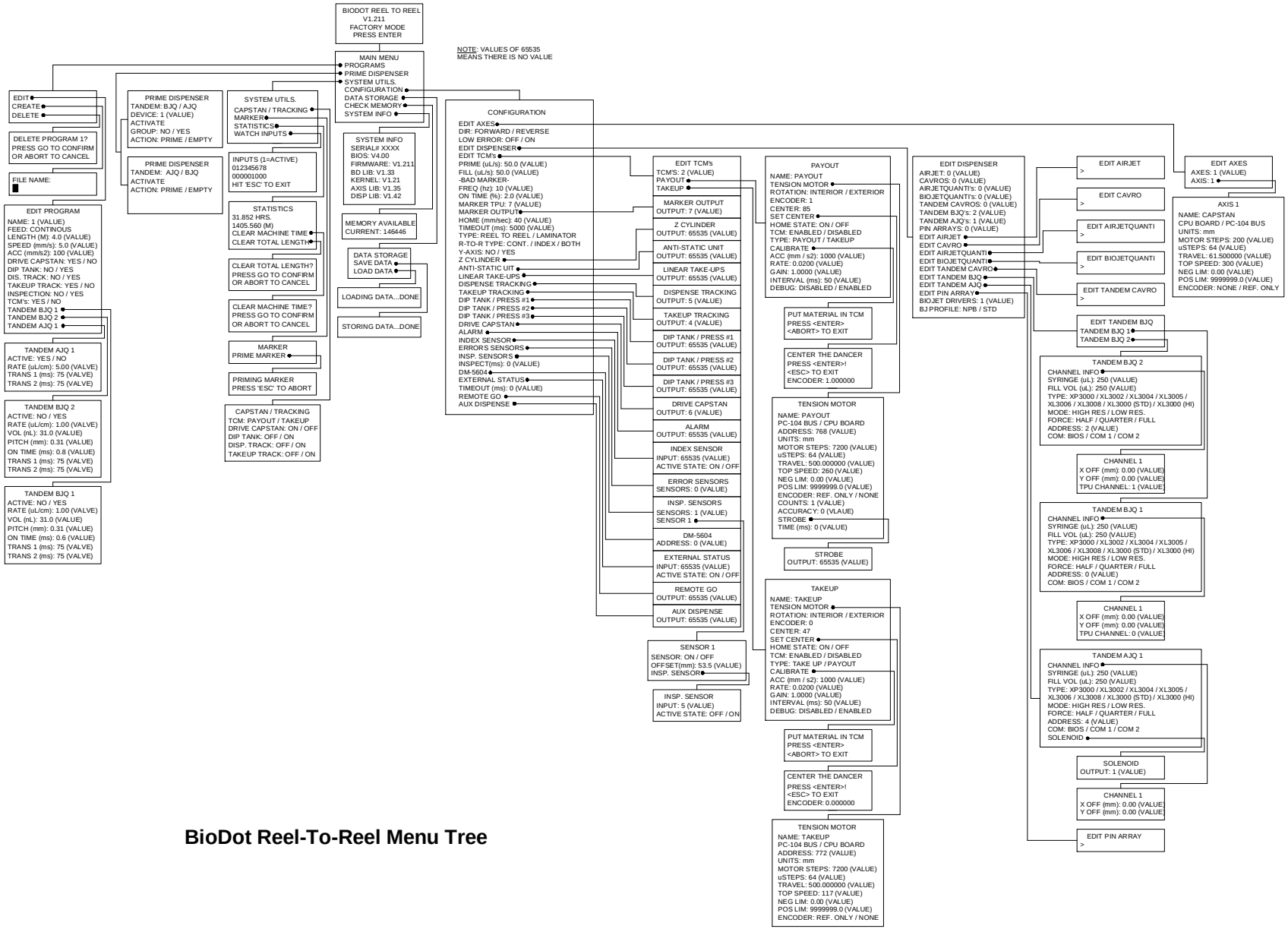
Hand-held Terminal Main Menu

Note: There are slight menu variations between platforms. The following menu trees are in FACTORY MODE. Some of the selections will not be available to the end user when in non-factory mode.

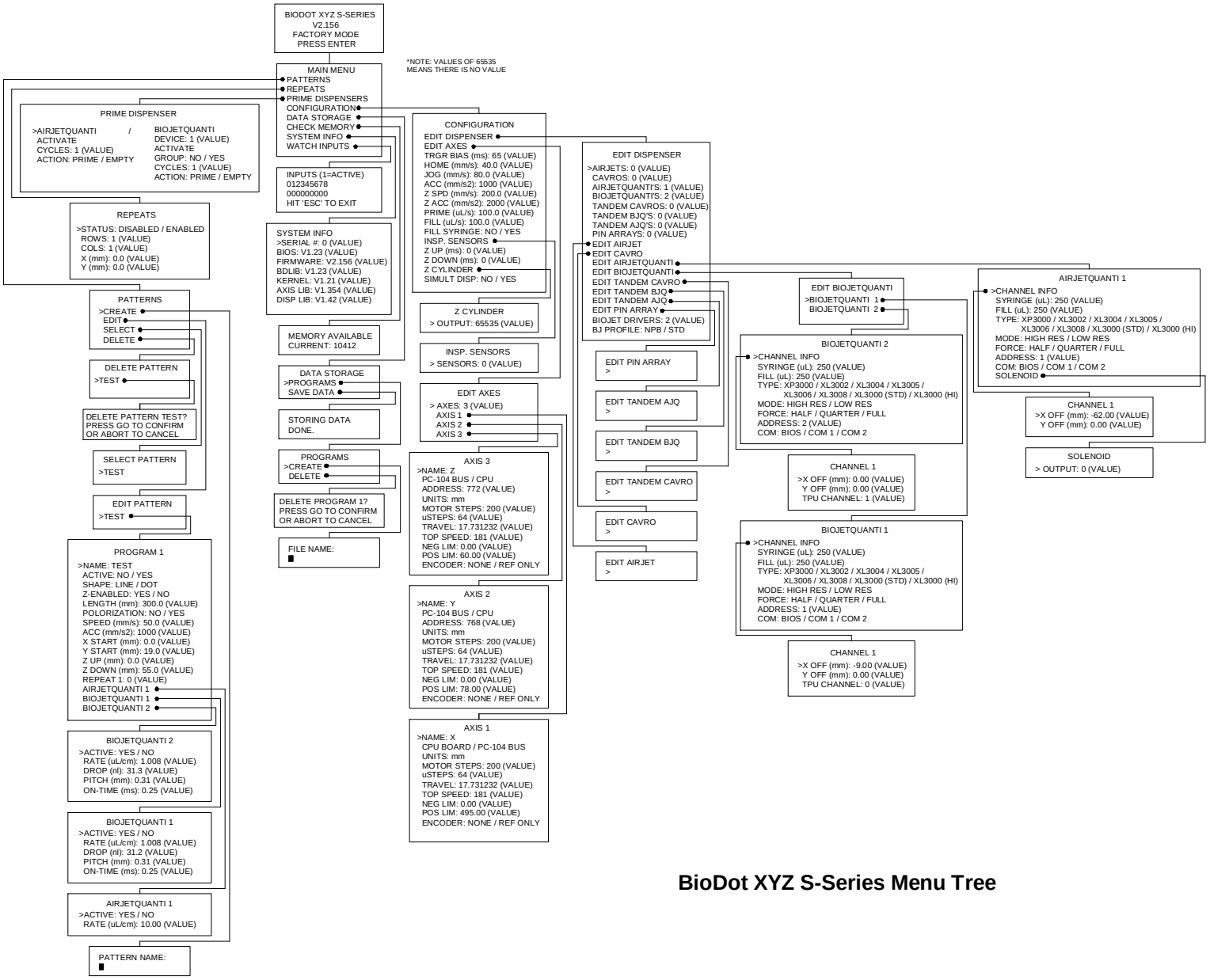
- **PROGRAM**

- **REPEATS** (XYZ platform only; used for programming dot matrices or rows of lines which require repetition of an individual pattern)
- **PRIME DISPENSER**
- **SYSTEM UTILITIES** (All platforms; system statistics, and the operation of system components (tracking, line inspection marking, etc.)
- **CONFIGURATION**
- **DATA STORAGE**
- **SYSTEM INFO** (All platforms; deals with hand-held terminal software information)

Please take a moment to look through the following menu hierarchy trees, which begin on the following pages. The first example will be the BioDot Reel to Reel platform. The second menu tree will be a tabletop platform.



BioDot Reel-To-Reel Menu Tree



BioDot XYZ S-Series Menu Tree

Entering and Saving Data

There are essentially three options when you are entering data; you will CREATE a new program, EDIT an existing program, or DELETE an existing program. The key to entering data is this: you must immediately save any new program data, or changes you make to existing programs, by selecting "SAVE DATA" under the "DATA STORAGE" menu. **ALL data will remain in *working memory* until it is formally saved in this manner**. **Warning: If the unit looses power any new programs will be lost if not saved**.

Creating and Deleting Programs

To create a new program, you must first enter a name for the program. After the name is saved into memory, you will then enter the desired web handling parameters for that program under the EDIT sub-menu.

Note: Creating the first program on a system platform where there are no programs in memory (i.e. when you first receive from the factory a system platform that has no "sample" programs entered for you) requires a different procedure than that for the creation of subsequent programs.

To create the first program name on a system platform:

- Select DATA STORAGE then PROGRAMS then CREATE (all platforms). Type in a program name using the terminal keypad, and press the ENTER key when finished.

To create a new program name:

- Select CREATE under the PROGRAM (Reel-to-Reel platform) or PATTERNS (XYZ or ZX platform) menu. Type in a program name using the terminal keypad, and press the ENTER key when finished.
- Immediately save the program name: using the ESC key, return to the main menu, and then select SAVE DATA under the DATA STORAGE menu.

To enter the program parameters for the new program:

- Return to the PROGRAM or PATTERNS menu and select EDIT. Review the EDIT sub-menu in the previous menu trees.
- Use the arrow keys to select menu options where you wish to enter data.
- Enter new data in each menu option field. Press the ENTER key after each completed entry.
- SAVE the program:

1. Using the ESC key, return to the main menu, and then select SAVE DATA under the DATA STORAGE menu.

Your new program is now saved (in *non-volatile memory*).

To delete a program:

- Select DELETE under the PROGRAM (Reel-to-Reel platform) or PATTERNS (XYZ or ZX platform) menu. Select the program name using arrow keys, and press the ENTER key. The program in now deleted.

PROGRAM and CONFIGURATION – the Dispenser Programming Menus

CONFIGURATION Menu

The information in this menu controls the platform speed, Z-axis (Z slide) movement, BioJet dispenser PRIME speed, and Syringe Pump speeds. Refer to menu trees on page 26 & 27.

EDIT DISPENSER

EDIT "DEVICE NAME" (BioJet or AirJet)	**Or**, EDIT "TANDEM BJQ/AJQ", for the Reel-to-Reel; this field selects the dispenser to be configured
	Note: A "device name" will not appear in the field if dispensing with a **Frontline dispenser** or **syringe pump** alone (where no BioJet/AirJet "device" is installed)

AirJet Configuration Sub-menus under EDIT:

CHANNEL INFO:	(See 4 X and 4 Y below)
CHANNEL 1:	
X OFF (mm):	A field used to inform the platform of the dispenser X axis location relative to the selected origin (home) in millimeters; **this is a factory setting**
Y OFF (mm):	A field used to inform the platform of the dispenser Y axis location relative to the selected origin (home) in millimeters (user should select)
TPU CHANNEL	Is the assigned BioJet channel (example: BiojetQuanti 1-Channel 1- TPU channel 0 would be BioJet channel #1 on the rear panel).

BioJet Configuration Sub-menus under EDIT:

CHANNEL INFO:	Same as AirJet Channel Info menus above (X and Y off)
SYRINGE (µl):	This is the syringe size in µl; the value must match the actual syringe on the pump so the programmed dispense volume can be correctly computed
FILL VOLUME (µl):	This is the volume the syringe will draw; it should be equal to or less than the syringe volume
FORCE: QUARTER/HALF/FULL	FORCE is the force achieved at the end of travel during the syringe plunger motion; it

	must be controlled to prevent damage to the syringe. FORCE should be selected as follows: QUARTER: If using syringes 100 µl or smaller HALF: If using syringes 250 µl or 500 µl FULL: If using syringes 1.0 ml or larger
PRIME (µl/sec):	This sets the syringe velocity when priming the BioJet Quanti: BioJet Quanti 3000 - Acceptable numbers range from 2 to 1000, with a typical value of 30 (BioJet Quanti 3000) for a 250 µl syringe.
FILL (µl/sec):	This sets the syringe velocity when filling the syringe from the reagent reservoir. Acceptable numbers range from 5 to 4000 with a typical value of 2000 for all syringe sizes.
WASTE X:	The X axis location where the dispenser will move to prime
WASTE Y:	The Y axis location where the dispenser will move to prime

Please remember that there are other CONFIGURATION menu options, which are specifically used to configure the system platform (platform HOME speed, etc). These are discussed in the appropriate system platform manual.

PROGRAM Menu

The PROGRAM (for the Reel-to-Reel platform) or PATTERNS (for the XYZ or ZX platform) menu is the primary menu for dispenser programming. It allows the operator to create, select, delete and edit programs. The PROGRAM menu, including the EDIT submenu where most of the dispenser programming fields are located, is discussed in depth in **Editing Existing Programs** later in the chapter).

REPEATS and PRIME DISPENSER – the Accessory Dispensing Menus

REPEATS

The REPEATS menu is only available in the XYZ or ZX platforms – the Reel-to-Reel platform does not support repeat patterns.

The REPEATS menu is used to repeat an entire active program. It is important to understand that this menu is separate from the REPEAT 1, 2 and Z fields under the EDIT submenus for designing a program. REPEAT 1, 2 and Z are used to repeat a **task** *within* a program. The REPEATS menu is used to repeat an entire **program**.

This is useful when you want to offset and repeat one or more programs. For example, you may wish to make thick lines from several parallel thin lines or to dispense identical patterns onto several different parts of the web.

To use the REPEATS feature, it is helpful to envision the dispense area on your web as an array of square grid elements divided into a number of rows and columns. Rows lie along the X-axis, while columns lie along the Y-axis. The sub-menus for the REPEATS menu are:

ROWS:	A field used to define the number of rows to be used for the pattern (program) repeat
COLUMNS:	A field used to define the number of columns to be used for the pattern (program) repeat
X (mm):	A field used to define the repeat offset for the X axis, in millimeters
Y (mm):	A field used to define the repeat offset for the Y axis, in millimeters

PRIME DISPENSER

The PRIME DISPENSER menu is available in all platforms, and is used to prime any of the available dispensers.

A dispenser should be primed in preparation for dispensing or cleaning. When the operator selects PRIME, they will first be prompted to select a dispenser type, and then the device number (from left to right) where there are more than one of that type of dispenser. Finally, the operator will enter the number of prime cycles for the dispenser selected.

The operator then selects and activates the ACTIVATE field to start the prime cycle at the prime speed set under the configuration menu (see **PROGRAM & CONFIGURATION – the Dispenser Programming Menus**). For BioJet dispensers, the solenoid valve will operate during the prime cycle at a factory set RATE and ON TIME that is appropriate for the PRIME cycle. The dispenser will continue to prime until the operator presses ESC on the hand-held terminal or the dispenser has completed the number of cycles.

Note: For any dispenser requiring the syringe pump, the first prime after the unit has been activated will not stop when the ESC key is pressed. The first prime after activation is an initialization prime that tells the syringe pump where the plunger is.

Editing Existing Programs

To edit a program, you simply modify the web handling parameters for that program under the EDIT sub-menu.

1. Select EDIT under the PROGRAM (Reel-to-Reel platform) or PATTERNS (XYZ or ZX platform) menu. Select the program to be edited using the arrow keys on the terminal keypad, and press the ENTER key.
2. Make necessary changes, using the arrow keys to select the menu options to be edited, and entering new data on the terminal keypad. Press the ENTER key after each new entry.
3. SAVE the new data:
   - Using the ESC key, return to the main menu, and then select SAVE DATA under the DATA STORAGE menu.

The Edit Sub-Menu

The EDIT sub-menu contains all the information to dispense lines or dots from one or more of the BioJet Quanti or AirJet Quanti dispensers. The Syringe pump and Frontline dispensers are configured under the CONFIGURATION menu (see **Creating and**

Deleting Programs). A complete description of the EDIT sub-menu is given in the table below, and in the following section, **EDIT Sub-Menu Options – Defined**:

Note: The Frontline and Syringe Pump dispensers are configured under the CONFIGURATION menu.

Reel-to-Reel Platform Dispensing Menus (DOT Task Not Available)	XYZ and ZX Platforms Dispensing Menus
EDIT Sub-Menu for BioJet and AirJet Dispenser: EDIT NAME: (names of created programs) Tandem *N*: (BJQ # 1 – 3 or AJQ # 1 – 3) (checkmark if enabled) (BioJet) ACTIVE: YES/NO RATE (ul/cm): VOL (nl): PITCH (Hz): ON TIME (ms): TRANS *n* (ms): (AirJet) ACTIVE: YES/NO RATE (ul/cm): TRANS *n* (ms):	**EDIT Sub-Menu for BioJet**: EDIT NAME: (names of created programs) ACTIVE: YES/NO DISPENSER: (BioJet *n*) Z ENABLED: YES/NO SHAPE: LINE / DOT LENGTH (mm): POLARIZATION: SPEED (mm/sec): ACC (mm/sec^2): X START (mm): Y START (mm): Z UP (mm) Z DOWN (mm) REPEAT 1: (These options UNDER BIOJETQUANTI 1 DROP (nl): PITCH (mm): VOLUME (µL/cm): ON TIME (msec): REPEAT 2: not available REPEAT Z: in ZX platform) X START (mm): Y START (mm): Z UP (mm) Z DOWN (mm) REPEAT 1: (These options UNDER BIOJETQUANTI 1 DROP (nl): TOTAL (nl): DROPS: # FREQ (Hz): ON TIME (msec): REPEAT 2: not available REPEAT Z: in ZX platform)

EDIT Sub-Menu for AirJet Dispenser:

EDIT

NAME: (names of created programs)

ACTIVE: YES/NO

DISPENSER: AirJet *n*

Z ENABLED: YES/NO

SHAPE: LINE / DOT

LENGTH (mm):

POLARIZATION:

SPEED (mm/sec):

ACC (mm/sec^2):

X START (mm):

Y START (mm):

Z UP (mm)

Z DOWN (mm)

REPEAT 1: (These options

RATE (µL/cm): ← UNDER AIRJETQUANTI 1

REPEAT 2: not available

REPEAT Z: in ZX platform)

X START (mm):

Y START (mm):

Z UP (mm)

Z DOWN (mm)

VOLUME (µL):

REPEAT 1: (These options

REPEAT 2: not available

REPEAT Z: in ZX platform)

EDIT Sub-Menu Options – Defined

Reel-to-Reel Platform Only	
NAME:	This is the name of the current program (selected program, under the " â SELECT" menu). To change the name, simply enter a new name and press ENTER.
TANDEM *n:*	There is *n* of these menu items: one for each dispenser for which the unit is configured, where the number *n* is the dispenser number from left to right when facing the platform. Submenus appear when a dispenser is selected, and a checkmark appears after the name of the dispenser in the TANDEM *n* field. The operator enters the dispense cycle parameters for each dispenser in the submenus:
Edit Sub-Menus:	
ACTIVE/RATE/ VOL/PITCH/ON TIME	Same as for XYZ/ZX platform; see below for definitions
TRANS	This field allows you to program the transition period, in milliseconds, between the end of one syringe pump stroke and the beginning of the other.
XYZ and ZX Platforms	
EDIT SUB-MENU FIXED OPTIONS:	
NAME:	This field displays the names of all saved programs. The operator selects a program to edit by using the arrow keys to scroll through the options and select the desired program, and the ENTER key to activate.
ACTIVE:	This is a toggle field (YES/NO) that sets the pattern state to active or inactive (this over-rides the SELECT menu option).
DISPENSER: (not in simultaneous dispense software)	There are *n* of these menu items: one for each dispenser for which the unit is configured, where the number *n* is the dispenser number from left to right when facing the platform. The operator selects a program to edit by using the arrow keys to scroll through the options and select the desired dispenser, and the ENTER key to activate. A checkmark subsequently appears after the dispenser selected (current).
SHAPE:	This is a toggle field that controls the type of dispense pattern: either a **dot** or a **line**. Selecting "DOT" will enable the pattern to dispense dots. Selecting "LINE" will enable the pattern to dispense lines (however, dots can be dispensed in the LINE task setting; see **BioJet Quanti 3000 Installation** for details). Some of the following menu items will change depending on whether dot or line is chosen.
Z ENABLED:	This is a toggle action that controls the Z-axis. When this function is ON, the Z-axis will move up and down during the pattern, and the Z UP and Z DOWN fields will be displayed (**see below**). If this function is OFF, then the Z-axis will stay in the up most position. This field is displayed for both LINE and DOT tasks.
DISPLAYED FOR LINE SHAPE ONLY:	
LENGTH (mm):	This field allows you to program the length (in mm) of your dispensed line, in either the X or Y direction. The standard length in the X direction is 370 mm (500mm optional). The maximum length in the Y direction is 70 mm for the XYZ3000 and 265 mm for the XYZ3200.
POLARIZATION:	This is a toggle action (YES/NO) that forces a line to be drawn in only one direction when turned to "ON." To

	speed dispensing of multiple lines, select “NO.”
SPEED (mm/sec):	The field allows you to program the rate at which the platform will move during the line dispense. Typical values are 50 and 100 mm/s. Speeds over 100 mm/sec are rarely necessary or appropriate, and are **not recommended**.
ACC (mm/s^2):	The Acceleration (ACC) is the rate at which the platform will accelerate up to the desired speed. Acceptable values range from 12 mm/sec^2 to 96,297 mm/sec^2. The operator can adjust this rate as necessary. At some platform speeds a high acceleration value may stall the motors. Typical acceleration values are around 1,000 mm/s^2.
PITCH (mm):	This field allows you to program the dot pitch, and is displayed for the LINE task only (X and Y start positions are used for the DOT task). Please refer to the **BioJet Dispenser Rate Tables in Appendix B** for appropriate rate settings.
VOLUME (µl/cm):	This field allows you to program the volume of liquid dispensed per unit length expressed in µL/cm and applies when the SHAPE menu has been toggled to the LINE option
RATE (µl/cm):	This field allows you to program the volume of liquid dispensed per unit length expressed in µl/cm and applies when the SHAPE menu has been toggled to the LINE option. **This field is available for Syringe pumps or AirJet dispensers only.**
REPEAT 1:	REPEAT 1 is used along with the X and Y start positions (versus dot **pitch** for the LINE task) to repeat an individual pattern. Several dots (or lines) can be drawn in a single pattern (line) allowing more flexibility in building complex dispense patterns. The REPEAT 1 function is used along with REPEAT 2 to create two-dimensional patterns (a matrix or grid pattern). For an example, see the **Dot Dispense Test** under **Test Programs for BioJet Dispensers** at the end of this chapter.
REPEAT 2:	REPEAT 2 is used along with REPEAT 1. This is a secondary level of individual pattern repeat that can be used to dispense a matrix of dots or lines. For an example, see the **Dot Dispense Test** under **Test Programs for BioJet Dispensers** at the end of this chapter.
REPEAT Z:	This is a toggle field (YES/NO) used to activate the REPEAT Z function. When activated, the Z-axis will raise to its Z UP position between each dispense within an executed program. When off, the Z axis will remain in the Z DOWN position between each dispense. Activating this option is useful, for example, if the dispenser must be raised out of a microtitre well between each dispense.
DISPLAYED FOR BOTH LINE and DOT SHAPE:	
X START (mm):	This field allows you to program the X-axis starting point relative to the coordinate origin (home), in millimeters.
Y START (mm):	This field allows you to program the Y-axis starting point relative to the coordinate origin (home), in millimeters.
Z UP (mm): (for 3050 & 3200 only)	Displayed on units with a motorized Z-axis only. This field allows you to program the start and end position in the Z-axis relative to the coordinate origin (home), in millimeters. Zero represents the upper-most position.
Z DOWN (mm): (for 3050 & 3200 only)	Displayed on units with a motorized Z-axis only. This field allows you to program the dispense position in the Z-axis relative to the coordinate origin (home), in millimeters. Zero represents the upper-most position.
DROP (nl):	This field allows you to program the volume of each drop. Please note that when the operator enters a volume, the software will round the value down based on the RATE, DROP PITCH, and ON TIME. A variety of volumes

	are achievable and the **BioJet Dispenser Rate Tables** indicate this information.
DISPLAYED FOR DOT SHAPE ONLY:	
TOTAL (nl):	This field is displayed for the DOT task only. This field is not editable and displays the total volume delivered for each dispense. The total volume is the product of the drop volume (see above) and the total number of drops delivered (see below). For example, if you enter VOLUME: 104 nL and DROPS: 10, then this field will display 1040 nL.
DROPS: #	This field is displayed for the DOT task only. This is the total number of drops to be dispensed.
FREQ (Hz):	This field is not displayed for the LINE task. The frequency, or number of droplets emitting from the BioJet Quanti, can be selected up to 1000 Hz.
VOLUME (µl):	This field allows you to program the volume per **dot** in µl and appears when the SHAPE menu has been toggled to the dot mode. **This field is available for Syringe pumps or AirJet dispensers only.**

You should now be ready to operate your dispensers. In the next section we discuss specifically the operation of the individual dispensers.

At the end of the chapter we have included three test programs for the BioJet dispenser. The test programs serve a dual purpose: they are diagnostic programs, and will determine proper functionality of the BioJets; and, because it is advisable to perform these tests after BioJet installation, they provide programming examples and practice to the new user.

BioJet Quanti 3000 Operation

General Operation

The BioJet Quanti dispenser is based on the combination of a solenoid valve to form drops, and a syringe pump to meter reagent. The BioJet Quanti takes advantage of the high-resolution stepper motors that drive the syringe pump by synchronizing the stepper increments with the opening and closing of the solenoid valve in the dispenser.

For continuous dispensing operations, two pumps are operated in tandem. The two pumps signal each other at a given time (the "transition time") before the end of their stroke, so that the other can begin its stroke at the appropriate time, thereby maintaining a constant pressure in the tubing that feeds the BioJet. The BioJet can be programmed to deliver distinct drops composed of one or more of these stepper increments, or streams of droplets to form lines.

Programming Considerations

The basic difference between a line and a series of dots is simply the drop *pitch*. Using the hand-held terminal, the operator programs a drop pitch that will increase or decrease the density of drops in a line. For every reagent type, there will be a minimum drop density that is necessary to obtain a continuous line.

Note: There must also be some consideration of protein binding on the choice of minimum drop density. If the protein binding is extremely fast, then the actual outline of the drop can be seen – giving a scallop effect to the edge of the line. Using smaller drops and a higher drop density to achieve the desired line concentration can minimize this. For high drop densities, the reagent can puddle on the membrane surface. This can result in splashing effect, as subsequent drops impact the liquid. Using lower table speeds with the same drop density, allowing more time for the reagent to be absorbed by the membrane, can minimize this problem.

The drop pitch is one of four BioJet dispensing parameters that are interdependent; changes in one of these four parameters must be accompanied by corresponding changes in the others. These parameters are: the dispensing *RATE*, in ul/cm; the *DROP VOLUME*, in nl; the *DROP PITCH*, in mm; and the *ON TIME*, in msec. These parameters form the basis for any BioJet dispensing program, and their values should be selected based on the **BioJet Dispenser Rate Tables** that are included in Appendix B of this manual. There are a variety of other dispensing program options, nearly all of which are located under the EDIT menu on the hand-held terminal, and are described under **Menu (Tree) Hierarchies** and **EDIT Sub-Menu Options - Defined** later in this chapter.

Sample programs for the BioJet are included in the last section of this chapter (see **Test Programs for BioJet Dispensers**). The test programs serve a dual purpose: First, they are diagnostic programs, and will determine proper functionality of the BioJets. Second, because it is advisable to perform these tests after BioJet installation, they provide programming examples and practice to the new user.

Line Dispensing

A line-dispensing program is entered using the EDIT sub-menu under the PROGRAM (Reel-to-Reel) or PATTERN (XYZ or ZX) menu. You will need to create a program NAME, select the DISPENSER (or DEVICE) to be used, and select the SHAPE (LINE or DOT) to be performed. Please see **Inputting Programs** for information on entering your desired program.

To design a line-dispensing program, we suggest you start with the RATE, DROP VOLUME, DROP PITCH, and ON TIME values that are appropriate for your application. Use the rate tables in Appendix B as a reference to your dispense parameters.

Once these four interdependent program parameters have been selected, you can then build on to your dispensing program using the remaining EDIT sub-menu option, such as line length, angle, platform speed, etc.

Dot Dispensing

As mentioned earlier, dot dispensing can be accomplished two ways: by using the DOT or the LINE task. To use the LINE task for dot dispensing, simply select LINE for your SHAPE option under the EDIT sub-menu. Then input a line-dispensing program with an expanded DROP PITCH. To use the DOT task for dot dispensing, simply select DOT for your SHAPE option under the EDIT sub-menu, and input a dot dispensing program. See **Inputting Programs** and **The Edit Sub-Menu** for details.

Priming the Dispenser

A dispenser should be primed in preparation for both dispensing and cleaning. You will use the PRIME DISPENSER menu to perform the priming sequence. The priming *speed* is selected under the CONFIGURATION menu. See **REPEATS and PRIME**

DISPENSER – the Accessory Dispensing Menus and **PROGRAM and CONFIGURATION – The Dispenser Programming Menus** for details on priming the BioJet. These sections are found in the **Inputting Programs** section of this chapter.

Configuring the Syringe Pumps

See **Syringe Pump Operation,** below.

AirJet Quanti 3000, 2300 and 2400 Operation

General Operation

The AirJet Quanti dispenser essentially operates by injecting a metered supply of reagent into a flowing air stream. Reagent is then aspirated onto the web material. Flow rate is controlled by the syringe pump and by adjustment of the needle micrometer on the AirJet. The AirJet is capable of dispensing lines or dots, with a wide range of dispensing rates and line widths (see **Chapter One – Dispenser Specifications**).

A cross sectional view of the end of the AirJet is shown in **Figure 10**. The fluid path opens into an orifice at the AirJet tip that is formed by the needle and nozzle. Adjusting the needle position in the vertical direction, using the needle micrometer, controls the size of the fluid orifice, and thus the rate of flow from the AirJet.

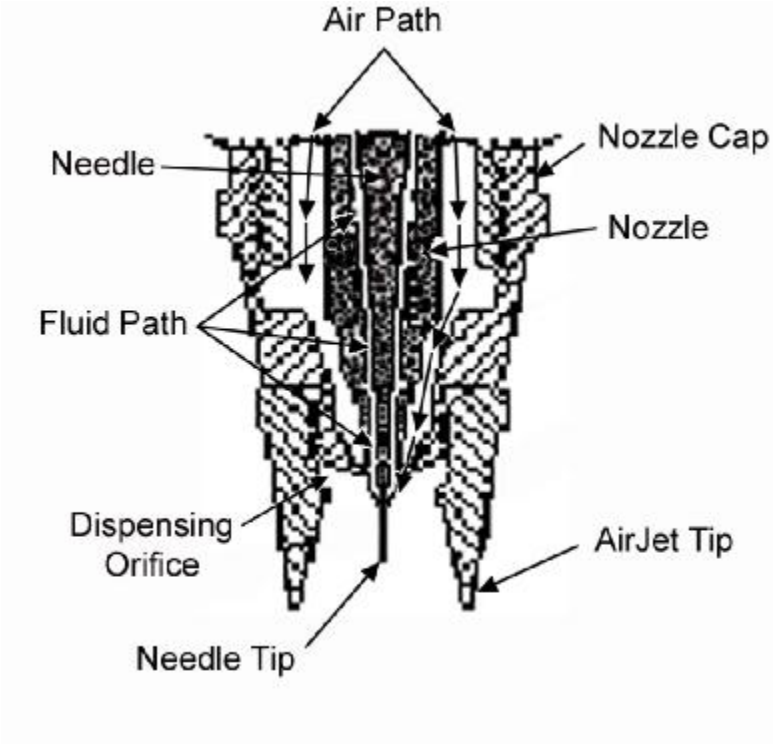


Figure 10

Control of Line Width and Volume

The **needle micrometer** on the top of each AirJet is the primary control over the dispensed volume. Turning the micrometer towards a larger number on the micrometer dial (counter-clockwise turn when looking down on the micrometer) backs the needle out of the nozzle, resulting in a larger fluid orifice and corresponding increase in the line width. The dispense rate is not affected by the needle position, but the shape and quality is extremely sensitive to small changes in needle position.

Warning:

Although the AirJet™ has been equipped with a positive stopping device to prevent needle/nozzle damage due to overdriving the micrometer, it is still necessary to refrain from using excessive force when closing the fluid orifice. Overdriving the micrometer could seriously damage the AirJet.

The **vertical micrometer** stage on each AirJet mounting platform is the primary control of line width. Spraying close to the material will result in a finer line. When operating extremely close to the material, it may be necessary to switch to the crown tip, which will allow the air stream to escape from the dispensing area through the cutouts in the tip. The crown tip is supplied in the tool kit and replaces the standard AirJet tip.

Z UP and Z Down Feature in AirJet Dispensing

For units with a pneumatic Z-Axis the Z DOWN feature is used to delay premature dispensing of the AirJet. An increase in time on the Z DOWN will allow the head to come down and wait before dispensing. This is useful in cases where you have a low air supply or worn components in the Z-Axis assembly.

The Z UP feature happens at the end of the dispense cycle and the Z-Axis is in the up position. An increase in time on the Z UP will allow the user time to reposition or remove a substrate. For multiple cycles the Z UP allows time for the previous pattern to set before the second pattern is applied.

Note: Delays are user and application defined. If you feel you need more time then program more time. If less, then program less. The viscosity of the solution, the rate that you are applying it and the substrate being used may also be determining factors on how long or short you program delays. It may take some trial and error to determine suitable delay times.

Line Dispensing

To design a line-dispensing program for the AirJet, we suggest you start with the RATE as a basis for your program. A line-dispensing program for the AirJet is entered using the EDIT sub-menu under the PROGRAM (Reel-to-Reel) or PATTERN (XYZ or ZX) menu. You will need to create a program NAME, select the DISPENSER (or DEVICE) to be used, and select the SHAPE (LINE or DOT) to be performed. Please see **Inputting Programs** for information on entering your desired program.

Dot Dispensing

Dot dispensing with the AirJet on an XYZ platform can be accomplished by using the DOT task (XYZ Platforms only). To use the DOT task for dot dispensing, simply select DOT for your SHAPE option under the EDIT sub-menu, and input a dot dispensing program. See **Inputting Programs** and **The Edit Sub-Menu** for details.

Priming the Dispenser

A dispenser should be primed in preparation for both dispensing and cleaning. You will use the PRIME DISPENSER menu to perform the priming sequence. The priming *speed* is selected under the CONFIGURATION menu. See **REPEATS and PRIME DISPENSER – The Accessory Dispensing Menus** and **PROGRAM and CONFIGURATION – The Dispenser Programming Menus** for details on priming the AirJet. These sections are found in the **Inputting Programs** section of this chapter.

Configuring the Syringe Pumps

See **Syringe Pump Operation**, below.

Frontline Quanti Operation

The Frontline dispenser itself requires no special programming, as the dispense rate from a Frontline dispenser is simply that of the syringe pump.

To operate the Frontline dispenser, you have only to properly install the specially designed dragging tip(s), set the angle and height of the dispenser per your application needs, and configure the Syringe Pump to deliver the proper rate of flow (see **Syringe Pump Operation**).

Syringe Pump Operation

The Syringe Pump dispenser contains a high-resolution stepper motor that is has 24,000 distinct “steps” or dispensing units per full stroke. Syringe Pump dispensers can be used alone or in combination with another dispenser (BioJet, AirJet or Frontline) to dispense reagent. Syringe Pumps can be wired together to work in tandem: in this case the two pumps signal each other at a given time (the “transition time”) before the end of their stroke, so that the other can begin its stroke at the appropriate time, thereby maintaining a constant pressure in the supply line tubing.

The programming fields for the operation of the syringe pump, with or without another dispenser, are located in the CONFIGURATION menu. Where a Syringe Pump is used alone or in combination with a Frontline Quanti Dispenser, only those fields related to Syringe Pump configuration will be shown.

Test Programs for BioJet Dispensers

This section is designed to help the user understand how to determine whether the BioJet Quanti dispenser is functioning correctly, and to how diagnose any observed problems. When using BioJets for any dispense, it must be remembered that the quality of the dispense observed can be affected by factors other than the performance of the valve itself, including characteristics of the fluid being dispensed, the material being dispensed onto, and ambient environmental conditions, such as humidity. As a result, determination of the performance of the BioJet valves themselves must be performed under optimized conditions.

Ideally, the fluid used should be water containing a small amount of detergent (e.g. 0.05% BioTerge). All fluids used should ideally be degassed and 0.2µm filtered before use. The protocol outlined here allows the user to focus on the operation of the valve itself by removing some of the variables of standard operation. Sample test programs are outlined for both old and new format programming ("Old Board" and "New Board"). **Note**: None for "Old first generation boards".

The user should employ these test programs in conjunction with the protocols described in **Cleaning and Maintenance of Dispensers** in attempting to remedy a problem, and in determining whether replacement of a valve is warranted.

Test Program Goals

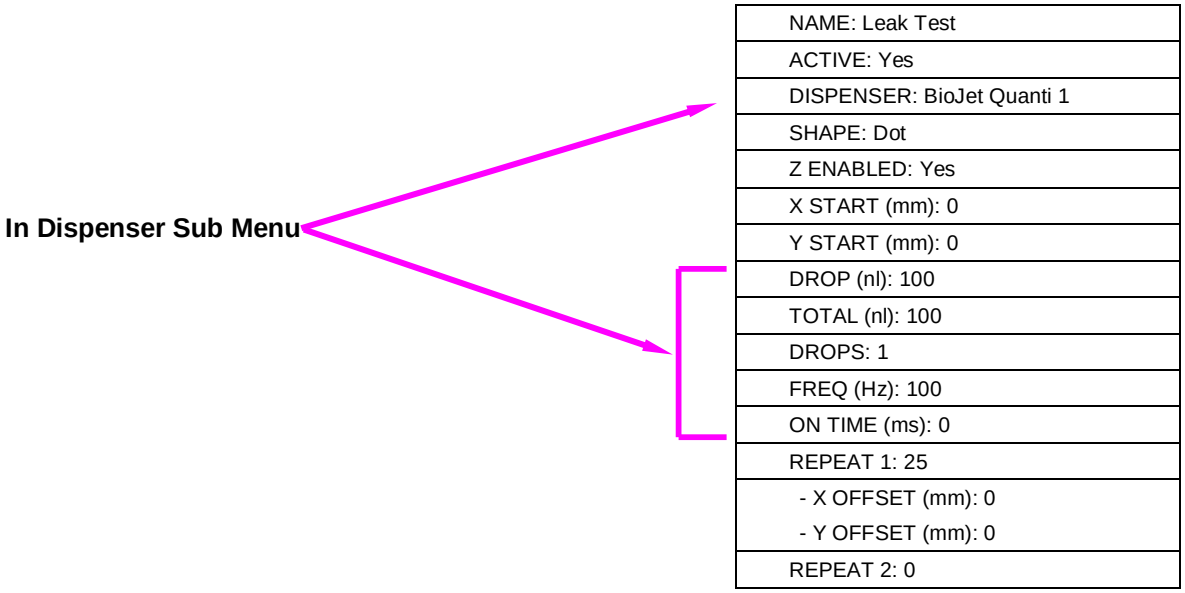
In determining correct operation of the valve, the operations to be observed are:

- The ability of the valve to prime correctly
- The integrity of the valve (i.e. does it leak)
- The ability of the valve to deliver a consistent dot
- The ability of the valve to dispense a consistent line

Leak Test

This program is designed to determine if the valve is leaking. The aim is to activate the dispenser but not open the valve, thereby determining whether fluid can be forced through a nominally closed valve. This sample program is written for XYZ or ZX platforms, but may easily be adapted for other platforms as well.

The Leak Test program is outlined below:



Leak Test Instructions

Using the Prime Dispenser command on the handheld controller, prime the BioJet with 0.05% BioTerge. Observe the dispense stream. The dispense should be in the form of a straight stream of fluid without splashing or sputtering. If splashing or sputtering occurs during dispensing, perform cleaning as outlined in “Maintenance and Cleaning of the BioJet Quanti 3000.”

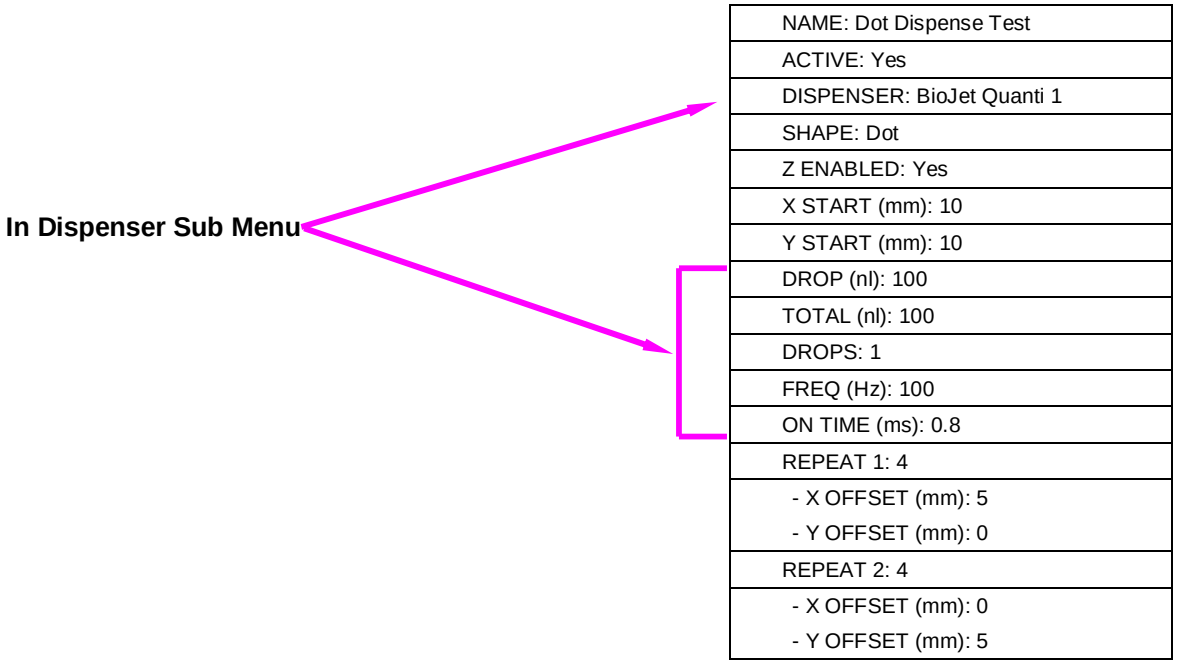
Wipe the tip clean before each run is performed. Examine the tip of the BioJet valve after the program has run. Determine if a meniscus of fluid has formed at the tip or if a droplet has fallen free. The valve passes (i.e. no leak is occurring) if no fluid has been forced through the valve. If a droplet is seen on the tip, a leak has occurred. To ensure that the leak has not occurred from the inlet tubing to the valve, remove the valve from the housing, leaving the electrical connector attached to the valve. Wipe the entire valve clean of any fluid. Repeat the test watching the inlet tubing specifically as a source of the fluid leak. If no fluid leaks from the inlet line, the valve itself has leaked.

The Dot Dispense Test, which tests for consistency in dot dispensing, should be applied next.

Dot Dispense Test

This program is designed to determine if the BioJets are capable of dispensing a consistent drop of fluid under optimal dispensing conditions. To do this, the user will program an array of drops (using the REPEAT function) of small to medium size and dispense 0.05% BioTerge onto the dispensing nest for ease of assessment of dot quality.

The Dot Dispense Test program is outlined below:



Dot Dispense Test Instructions

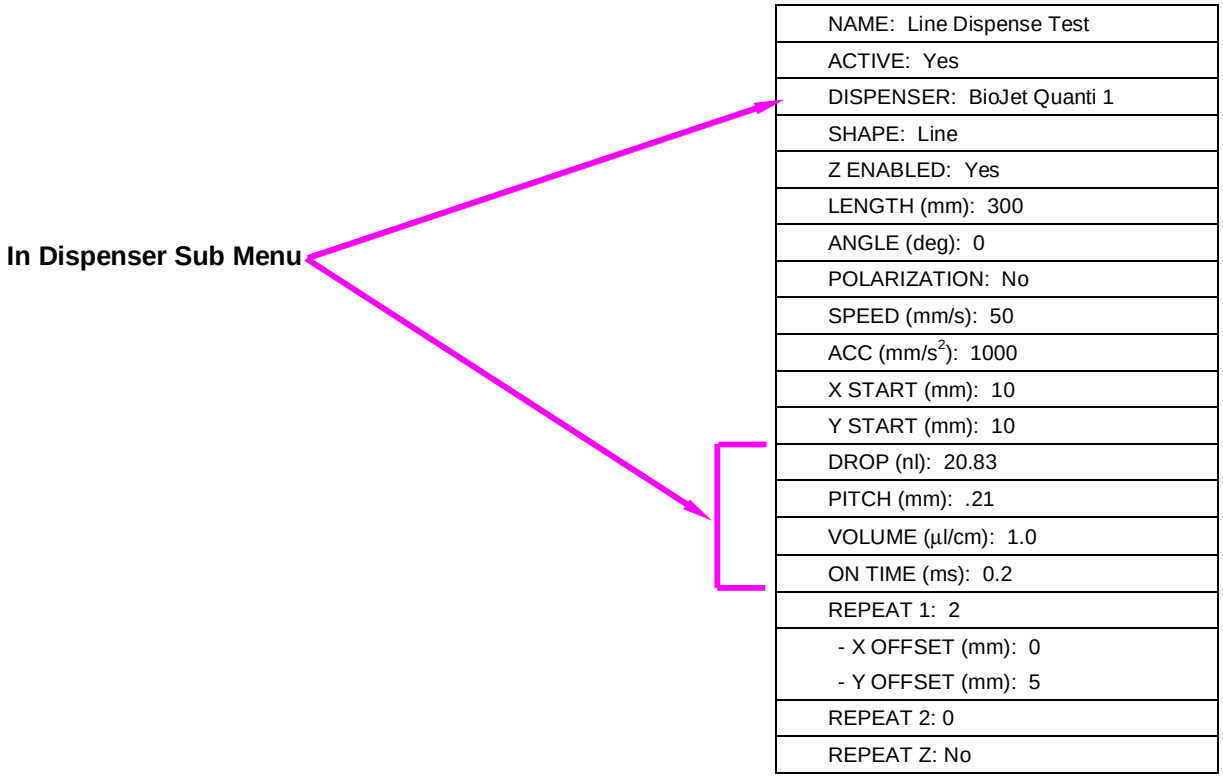
Prime the dispenser prior to performing the test.

Examine the arrays of dots for drop consistency, for satellite drops or spray, or for missed dispenses. The valve passes if dots are consistent, none have been missed and there is no spray or satellite drop formation.

Line Dispense Test

This program is designed to determine if the BioJets are capable of dispensing a consistent line of fluid under optimal dispensing conditions. To do this, program an array of lines of medium size and dispense fluid onto a suitable medium for ease of assessment of line quality. Bare in mind that the results of this test can be affected by the material you are dispensing on. Parafilm™ is a good material to use for this purpose as it often creates fewer problems from static electricity than nitrocellulose, for example. Examine the lines for consistency, for satellite drops or spray, or for breaks.

The Line Dispense Test program is outlined below:



Line Dispense Test Instructions

Prime the dispenser prior to performing the test.

Determine whether satellite drops are present or there is sputtering from the valve or significant breaks in the dispensed line that are not attributable to air in the fluid lines. The valve passes if none of the above is present.

Remedial Actions

If the valve fails any of the above tests, undertake cleaning as outlined in **Cleaning and Maintenance of Dispensers** and retest the valve for performance. Once all cleaning procedures, including the unclogging procedures outlined in that protocol have been performed, retest the valve for performance as above. If the valve passes the inspections it may be considered suitable for continued use. If the valve does not pass the above inspections, it may be concluded that the valve needs to be replaced.

If the valve passes the above tests and inconsistencies are being observed in the dispense of your fluid of interest onto its substrate, then it is likely that factors other than valve performance are involved. Factors which can lead to inconsistent dispenses include:

- Particulates in the fluid, either present intentionally or as artifacts. If possible, filter fluids prior to dispensing
- Inconsistencies in the receiving substrate. For example, some membranes, particularly if treated with detergents, can contain hydrophobic patches that lead to inconsistent absorption characteristics. Particulates or dust on the surface of nitrocellulose membranes can also result in inconsistent absorption
- Static electricity. If static is present, either caused by dry ambient conditions (low relative humidity) or by the receiving substrate (e.g. un-backed nitrocellulose can generate a significant static charge), inconsistencies in dispense may be expected as drops are deflected from their trajectory. If possible, use anti-static bars and work in a slightly humid environment to overcome this problem

CHAPTER FOUR - CLEANING AND MAINTENANCE OF DISPENSERS

Background

This chapter describes preventative maintenance and cleaning procedures for the BioJet Quanti 3000; AirJet Quanti 3000, 2400 and 2300; Frontline Quanti 1000, and Syringe Pump dispensers. To achieve optimum performance and maximum life from your dispenser, it is recommended that you clean the dispenser after each period of use, and perform a more stringent follow-up cleaning regime on a weekly basis. To minimize clogging of the dispensers and/or dispensing tips, and the attendant necessity of performing mechanical cleaning (e.g. sonication, back flushing) which can damage dispenser valve components, we strongly recommend the strict adherence to the cleaning protocols described in this chapter.

The goal of this chapter is to provide the user with a **Daily Cleaning** protocol, **Weekly Cleaning and Decontamination** protocols that are appropriate for your dispensing application, and **Unclogging** methods for troubleshooting clogged dispensers or dispensing tips.

Key Words

None

Tools/Equipment

- Set of Allen wrenches (provided with the unit)
- BioTerge (detergent)
- Jetwash (detergent)
- Deionized water

Procedure – Cleaning and Maintenance of BioJet, AirJet, and Frontline Dispensers

Daily cleaning

We recommend the following cleaning procedure for the routine maintenance of your dispensers. This procedure should be performed after each period of use. In general, reagents should not be allowed to dry in the dispensers or their supply lines.

1. Purge lines of reagent.
2. Clean and refill the supply bottle with deionized water containing 0.05% BioTerge to enhance scrubbing of interior recesses within the BioJet Quanti™.

3. Prime dispenser for 5 syringe cycles.
4. Repeat steps 1 through 3 with deionized water.

Weekly cleaning and Decontamination – Standard Procedure

After prolonged dispensing of reagents, some buildup of protein constituents, salts, latex materials, or other particulate matter may occur. It is recommended that the following cleaning steps be followed on a weekly basis to dissolve any accumulated materials. This should be performed in addition to the daily cleaning procedure.

1. Purge supply lines of reagent.
2. Clean and refill the supply reservoir with a dilute base (0.1N NaOH). Prime the BioJet Quanti™ for 5 syringe cycles and allow to sit for 10 minutes.
3. Prime using deionized water as in steps 1 and 2 above.
4. Clean and refill the supply reservoir with a dilute acid (0.1N HCl). Prime the BioJet Quanti™ for 5 syringe cycles and allow to sit for 10 minutes.
5. Purge the supply lines and prime for a minimum of 10 cycles using deionized water.

Weekly cleaning and Decontamination – Alternative for Systems With a Narrow pH Tolerance

This procedure should be performed in systems dispensing proteinaceous reagents or where acid/base use is undesirable. This procedure may also be performed as part of the regular weekly cleaning protocol in addition to the standard weekly procedure. It is of particular value in helping to prevent cross-contamination when dispensing multiple reagents from a single dispenser, or to clean protein buildup from the lines and the valve.

Note: You must validate the decontamination procedure to ensure its adequacy in your own application.

1. Purge supply lines of reagent.
2. Prime 3 cycles of deionized water with 0.05%. BioTerge through the system.
3. Prime this solution out of the system.
4. Prime Jetwash into the system and allow the solution to sit in the BioJets for 30 minutes.
5. Prime this solution out of the system.
6. Clean and refill the supply reservoir with deionized water.
7. Prime dispenser for 5-10 syringe cycles.
8. Remove the glass syringe from the syringe pump.
9. Remove the plunger from the syringe and flush deionized water through the open syringe and wash the plunger in deionized water being careful not to damage the plunger seal.
10. Flush deionized water through the ports in the 3-port valve. The valve stem may be turned by hand to switch path positions.

Unclogging Procedure

If clogging of the BioJet should occur, then the following procedures may be followed.

Sonication

The entire dispenser housing, when removed from the supporting arm, may be sonicated in deionized water if the dispenser becomes partially or totally clogged. Disconnect the dispenser from all electrical power before sonicating. The BioJet should generally not be sonicated unless clogging occurs.

Back flushing

Back flushing simply means to push fluid through the BioJet in the reverse direction from that which is normal. The procedure is as follows:

1. Remove the BioJet from its housing - you can do this by removing the tip, pulling back on the mechanical spring on the top of the housing and then sliding the BioJet out of the housing.
2. Disconnect the tubing from the top of the BioJet but leave the electrical lead connected.
3. Obtain a syringe and a blunt 21-gauge needle - the 21-gauge needle fits very snugly inside the end of the BioJet. If you do not have this, you can use tubing that will fit over the syringe end and over the entire BioJet end. You need to create as snug a connection as possible.
4. Fill the syringe with water and carefully insert the needle into the end of the BioJet.
5. Run several PRIME cycles and when the BioJet is open to allow fluid through (i.e. when the syringe is dispensing), slowly push the water from the syringe through the BioJet. It may require some pressure at first to "unstick" the poppet. Once the poppet is unstuck, water should drip from the inlet nozzle of the BioJet.
6. If water comes through the inlet nozzle, then reconnect the tubing and tip to the BioJet as usual and run a prime to verify that fluid can prime through.

Note: If something has solidified in the valve that can be re-dissolved by the use of a solvent, which is compatible with all materials in the BioJet, then that solvent may be used for this procedure.

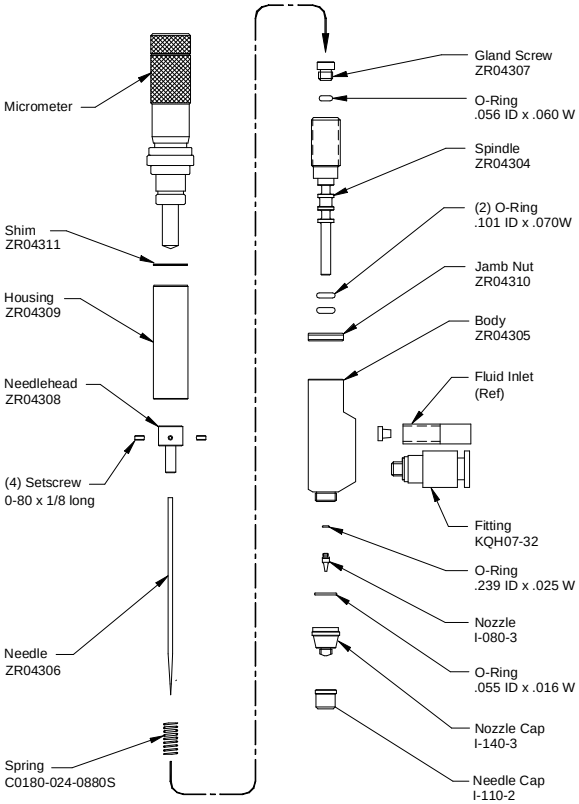
Procedure for AirJet assembly

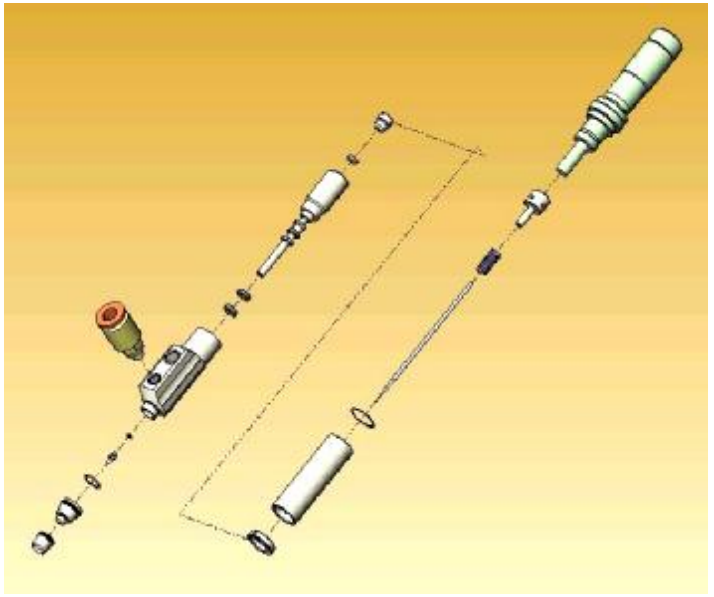
AirJet Specifications

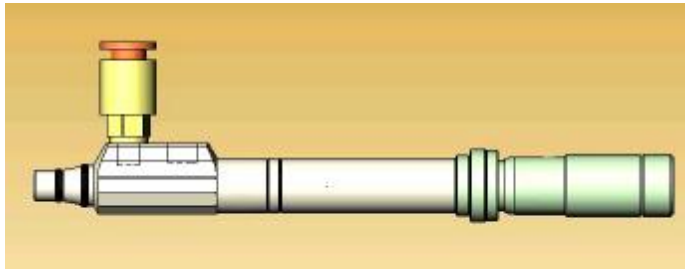
Topic	AirJet Quanti 2300	AirJet Quanti 2400	AirJet Quanti 3000
Repeatability	± 1% (Line Dispensing) **3**	± 1% (Line Dispensing) **3**	± 1% (Line Dispensing) **3**
Nozzle / Needle Size	-0.6mm	-0.8mm	-0.3mm
Dispensing Range Lower Limit Upper Limit	 1 µL per cm <30 µL per cm **2**	 1 µL per cm 80 µL per cm **2**	 1 µL per cm 22 µL per cm **2**
Line Width **1**	0.04” to 0.60”	0.08” to 1.00”	0.02” to 0.24”

Typical Width Range	(1 mm to 15 mm)	(2 mm to 25 mm)	(0.5 mm to 6 mm)
Swept Volume **4** % Recoverable	1.8 µL (approx) <98%	1.8 µL (approx) <98%	1.5 µL (approx) <98%
Requirements	Between 10-40 PSIG (clean & dry)	Between 10-40 PSIG (clean & dry)	Between 10-40 PSIG (clean & dry)
Air Pressure	Tubing 1/8" ID x 1/4" OD Tygon™	Tubing 1/8" ID x 1/4" OD Tygon™	Tubing 1/8" ID x 1/4" OD Tygon™
Feed Line	Tubing 1/16" ID TFE	Tubing 1/16" ID TFE	Tubing 1/32" ID TFE
Materials	Stainless Steel	Stainless Steel	Titanium / Stainless Steel
Available Syringes	50µL /100µL /250µL / 500µL / 1mL	50µL /100µL /250µL / 500µL / 1mL	50µL /100µL /250µL / 500µL / 1mL
Power Requirements	Power Derived From a BioDot Dispensing Platform	Power Derived From a BioDot Dispensing Platform	Power Derived From a BioDot Dispensing Platform

1 - Width is highly dependent on absorption properties of the substrate and fluid rheology.
2 - Dependent on fluid rheology. Based on consistent and reproducible dispense of 0.05% BioTerge in water over a 30 cm path length.
3 - Based on 5µL/cm over 30 cm path.
4 - Based on 250µL syringe and minimum usable tubing lengths.







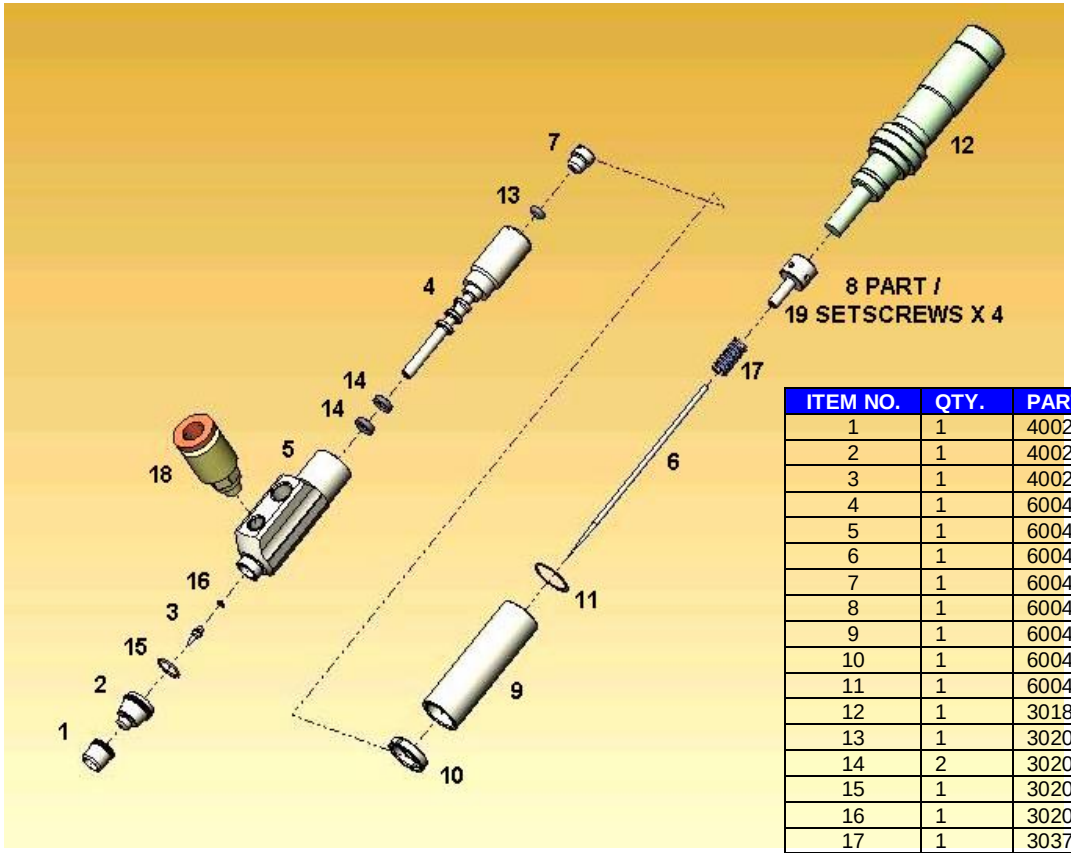
AirJet Dispenser

Troubleshooting

Platform	Symptom	Possible Cause
2500/3000/3050/3200/5000	AirJet - General Tips.	• Ensure that the proper dispenser has been selected in the Program. • Ensure that all reagent lines are connected securely and are free of clogs and leaks. • Ensure that the proper volume is entered in the Program. Programmed volume should not be less than 1 µl/cm. • Ensure that the dispenser has been properly primed. • Ensure that the appropriate syringe size has been configured. • Ensure that the airlines are connected properly and the appropriate amount of pressure is applied to the AirJet. • Ensure the micrometer atop the AirJet is open sufficiently. • Ensure that the dispense head is at an appropriate distance from the surface of the substrate (approx. 1-3 cm). • Ensure that the air pressure is set appropriately. The AirJet is commonly operated at 8-10psi. • Ensure that the transition times (Trans 1 and 2) are set correctly for the fluid you are dispensing. These settings are determined empirically and may differ for each fluid and tandem pump set. Having these settings correct will ensure that no gaps or bulges in dispensed lines will occur upon pump transition.
	AirJet - Breaks in lines.	• Check air pressure, height of dispense head above substrate and opening of micrometer. Generally air pressure is operated at 8-10 psi, and the micrometer is set at 1-3 for commonly dispensed fluids such as gold conjugates or blocking reagents. Alter one parameter at a time until line quality improves.

AirJet 3000 Assembly Procedure

Note: All item numbers reference the drawing sheet below. Use tools supplied by manufacturer.



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	4002-0013	TIP, CROWN, AIRBRUSH, .3MM
2	1	4002-0005	CAP, NOZZLE, AIRBRUSH, .3MM
3	1	4002-0009	NOZZLE, AIRBRUSH, .3MM
4	1	6004-0304	SPINDLE, AJ3000
5	1	6004-0305	BODY, AJ3000
6	1	6004-0306	NEEDLE, AJ3000
7	1	6004-0307	SCREW, GLAND, AJ3000
8	1	6004-0308	NEEDLEHEAD, AJ3000
9	1	6004-0309	HOUSING, MICROMETER
10	1	6004-0310	NUT JAM, AJ3000
11	1	6004-0311	SHIM, AJ3000
12	1	3018-0000	MICROMETER HEAD, .50 TRAVEL
13	1	3020-0008	O-RING, AS568A-003, .56 ID X .060 W, EPDM
14	2	3020-0009	O-RING, AS568A-005, .101 ID X .070 W, EPDM
15	1	3020-0005	O-RING, .239 ID X .025 W, EPDM
16	1	3020-0002	O-RING, .055 ID X .016 W, EPDM
17	1	3037-0000	SPRING COMPRESSION, .180 X .024 WIRE
18	1	4001-0039	FITTING, MALE ADAPTER, 1/4 TUBE OD, 10-32 THD
19	4	3030-0050-00	SCREW, SET, CUP POINT, 0-80 X 1/8 LONG

- Assemble tube connector, item 18, to the AirJet body, item 5, and tighten securely.
- Place o-ring, item 15, onto thread undercut of AirJet body, making sure that there are no nicks or blemishes on the o-ring surface, which may cause it to leak.

- Assemble the nozzle cap, item 2, to the AirJet body and tighten firmly by hand. Temporarily set AirJet body aside.

- Assemble two o-rings, item 14, onto spindle, item 4, by sliding over steps in spindle. **Note**: It may be desirable to use an assembly aid, such as some alcohol or water, in order to more easily stretch the o-ring over the diameter step in the spindle.

- Install o-ring, item 13, into the bore of the spindle so that it is fully seated. It may be difficult to seat the o-ring perfectly flat against the stop. Some o-ring distortion is permissible as long as light can pass through the o-ring inside diameter.

- Assemble gland screw, item 7, into the spindle and tighten.

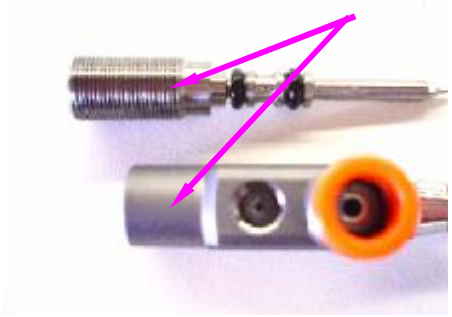
  - § **Stop**: At this time verify that a test needle, similar to item 6, can be installed into the rear of the assembly without snagging or damaging the previously assembled o-ring. The needle should slide smoothly and have a moderate amount of drag. If damage has occurred, replace o-ring as in step e). Be cautious when handling the needle as the tip may easily become damaged.

- Assemble o-ring, item 16, over the threads of the nozzle, item 3, making sure it is seated against the nozzle flange.

- Assemble the nozzle into the small end of the spindle and tighten.

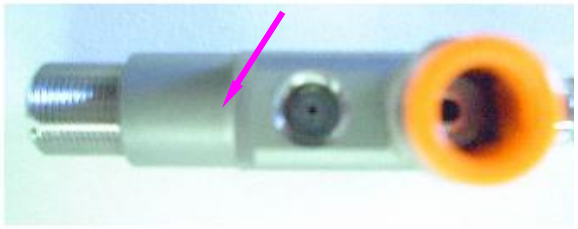
  - § **Warning: Do not over tighten as the threads of the nozzle are very weak and will break off easily**.

- Thread the spindle into the body until the tip of the nozzle extends slightly beyond the front face of the nozzle cap. Line up the second hole in the spindle with the hole in the feed line port. **Note**: The hole goes all the way through the spindle, so you have a ½ turn tolerance. Refer to photo.



Line This Hole With Hole In Body

Spindle Hole Inline With Hole In Body



- Assemble the jam nut to the spindle threads and tighten in place. Use the spanner wrench supplied with the micrometer, item 12, to accomplish this.

- Insert the four setscrews, item 19, into the needle head, item 8, and allowing tip of setscrew to remain slightly above flush with the outside of the needle head.

- Trial fit needle head into rear of spindle so that it is fully seated. Slide the needle, item 6, through the rear of the needle head until it is exposed at the front of the nozzle. At this point, the rear of the needle should be below flush with the rear of the needle head.

  § **Warning: Be extremely careful not to damage needle tip, as it can be easily damaged. If resistance to insertion is found stop (refer to Stop above) and reexamine cause before proceeding**.

- While holding the needle head against the spindle and holding the needle fully seated against the nozzle, tighten all four setscrews a like amount and secure needle in place.

- Remove assembled needle and needle head, and reassemble with spring, item 17, in place.

- Assemble needle cap item 1, to front of AirJet body to protect needle when fully extended.

- Assemble micrometer-housing, item 9, to expose spindle threads and tighten by hand.

- Trial fit micrometer, item 12, in place at end of micrometer housing and note position of fixed scale graduations relative to incoming fittings on AirJet body. **Add shims, item 11, as necessary** so that graduations are on opposite side of AirJet body from incoming air and fluid fittings. Once established, remove the micrometer.

  § **Warning: Make sure barrel of micrometer is rotated slightly open to allow body of micrometer to be fully seated. If micrometer barrel is difficult to rotate, loosen locking ring near base of micrometer**.

- Rotate micrometer to close position and note that needle extends slightly from nozzle when viewed from end. Loosen the setscrew located in the knurled portion of the micrometer. Rotate and slide the micrometer barrel so that zero hash mark and edge of micrometer barrel are positioned at the zero hash mark on the fixed micrometer scale. Tighten setscrew and rotate micrometer barrel to confirm proper scale match up at seated position. If the position cannot be reached add a few more shims then try to readjust.

- Functionally test and observe that liquid flow begins at approximately 1 to 2 mils from fully closed.

APPENDIX A – TROUBLESHOOTING

BioJet Dispenser Troubleshooting Guide

PROBLEM	POSSIBLE SOLUTIONS
General Tips	- Ensure that the proper dispenser has been selected in the Program. - Ensure that all reagent lines are connected securely and are free of clogs and leaks. - Ensure that the proper volume is entered in the Program. Programmed volume should not be less than 0.2 µl/cm or this drop size. Drop size may vary depending on application. - Ensure that the pitch and on-time values are appropriate for the dispense volume entered. Consult dispenser tables. - Ensure that BioJet valves and PBT tips are clean and free of obvious defects. - Ensure that the BioJet cables are connected properly. - Ensure that the proper dispense head height is set using the micrometer. Optimum dispense height for BioJets is approximately 2-4 mm from web surface. - Ensure that the dispenser has been properly primed. - Ensure that the appropriate syringe size has been configured. - Ensure that the transition times (Trans 1 and 2) are set correctly for the fluid you are dispensing. These settings are determined empirically and may differ for each fluid and tandem pump set. Having these settings correct will ensure that no gaps or bulges in dispensed lines will occur upon pump transition.
BioJet Valve does not fire (as determined by the absence of fluid coming from the valve and the absence of the distinctive sound of the valve firing)	- Ensure that the proper dispenser has been selected in the program. - Ensure that the BioJet cables are connected properly.
Fluid appears to be leaking from the system	- Ensure that all reagent lines are connected securely and are free of clogs and leaks. - Check all connections. Check lines and plunger seal integrity on the syringe. Replace seals or syringe as necessary. - Ensure that the pitch and on-time values are appropriate for the dispense volume entered. Pressure build-up due to incorrect on time may lead to leaks in the system.
Excessive air bubbles develop in the reagent lines	- De-gas the fluid before attempting to dispense. - Check all connections for air-tightness. - Check valve for leaks (see protocol attached). - Slow the prime speed.
BioJet Valve does not prime correctly – the fluid stream is deflected, is not continuous, or splashing is extreme.	- Check the valve with a new tip. If using a molded tip, change to a PBT tip if possible. If this does not solve the problem, the valve may be clogged. Perform cleaning protocol in Chapter Four and retry the valve. If the problem persists, replace the valve.

During dispensing, the BioJet Valve does not dispense a continuous line.	- Line quality is derived from a number of factors, including operation of the valve, the characteristics of the material being dispensed onto, the characteristics of the fluid being dispensed and environmental conditions. Do not automatically assume that any one of these parameters is responsible for the absence of the line quality you desire. Most often it is a combination of issues. Typical problems with line dispenses are as follows: Breaks in lines: - Ensure that the proper dispense head height is set using the micrometer. Optimum dispense height for BioJets is approximately 2-4 mm from web surface. - Check the system for air. If bubbles are forming perform the procedure as described above for ridding the system of air bubbles. If air is not visible in the system there can still be an air bubble trapped in the valve. Perform the back flushing procedure outlined in the cleaning protocol. The valve may also be clogged with particulates. All fluids should be 0.2 μm filtered if possible before dispensing to prevent the buildup of particulates in the valve poppet. Some buildup of particulates in the valve is always expected. For this reason it is essential that the cleaning procedures outlined in this manual be scrupulously followed. Deflection of droplets. Fluid is spraying away from the line causing satellites or splashing on the material: - This can be caused by a number of things. The valve may be clogged with particulates. Perform the cleaning procedure in Chapter Four. There may be an imperfection in the tip, particularly if the tip is a molded plastic tip. Change the tip if possible, and if possible change to a PBT tip if a molded plastic tip is being used. Static buildup on the material can cause drops to be deflected from their target. If possible, work in relative humidity of >30% when striping nitrocellulose in particular. Humidify the area if necessary. Line quality is generally poor: - Thick lines, breaks in lines, poor absorption into the membrane can all be caused hydrophobic patches in the membrane due to poor quality membrane being used, or membrane being stored for too long or in less than optimal conditions. Try a different membrane for comparison purposes.
BioJet Valve is suspected of dispensing incorrect volume	- Check the volume dispensed using the **Test Programs for BioJet Dispensers** in Chapter Four of the manual.
Diagnosing the BioJet valve	-Check for visual signs of damage to the valve. -Verify the coil resistance is correct: A) If resistance is infinite then the coil winding has broken most likely due to over powering; voltage, or overheating; ambient cooling is too low. B) If resistance is too low then the coil winding has broken, or insulation on coil winding has melted, and the electrical flow path is not through the whole coil. -Check for contamination internal to the valve, which will cause leakage or no flow, by pressurizing the inlet port with air and routing the outlet port under water via tubing. No visible signs of air bubbles dispensing from the outlet of the tubing should be present.

AirJet Dispenser Troubleshooting Guide

Problem	Possible Solutions
General Tips	- Ensure that the proper dispenser has been selected in the Program. - Ensure that all reagent lines are connected securely and are free of clogs and leaks. - Ensure that the proper volume is entered in the Program. Programmed volume should not be less than 1 µl/cm. - Ensure that the dispenser has been properly primed. - Ensure that the appropriate syringe size has been configured. - Ensure that the airlines are connected properly and the appropriate amount of pressure is applied to the AirJet. - Ensure the micrometer atop the AirJet is open sufficiently. - Ensure that the dispense head is at an appropriate distance from the surface of the substrate (approx. 1-3 cm). - Ensure that the air pressure is set appropriately. The AirJet is commonly operated at 8-10psi. - Ensure that the transition times (Trans 1 and 2) are set correctly for the fluid you are dispensing. These settings are determined empirically and may differ for each fluid and tandem pump set. Having these settings correct will ensure that no gaps or bulges in dispensed lines will occur upon pump transition.
Breaks in lines	- Check air pressure, height of dispense head above substrate and opening of micrometer. Generally air pressure is operated at 8-10 psi, and the micrometer is set at 1-3 for commonly dispensed fluids such as gold conjugates or blocking reagents. Alter one parameter at a time until line quality improves.

APPENDIX B – BIOJET DISPENSER RATE TABLES

BioJet Quanti ä Line Dispensing Parameters: 50 – 100 mL Syringe, 0.2 to 5.0 mL/cm Dispense Rate

50 mL Syringe

RATE µl/cm	DROP VOLUME (nl)	DROP PITCH (mm)	ON TIME (msec)
0.2	4.17	0.21	0.20
	6.25	0.31	0.20
	8.33	0.42	0.20
.25	4.17	0.17	0.20
	6.25	0.25	0.20
	8.33	0.33	0.20
	10.42	0.42	0.20
0.3	4.17	0.14	0.20
	6.25	0.21	0.20
	8.33	0.28	0.20
	12.50	0.42	0.20
.4	6.25	0.16	0.20
	8.33	0.21	0.20
	12.50	0.31	0.20
	16.67	0.42	0.20
.5	10.42	0.21	0.20
	16.67	0.33	0.20
	25.00	0.50	0.20
.6	12.50	0.21	0.20
	16.67	0.28	0.20
	25.00	0.42	0.20
.7	14.58	0.21	0.20
	16.67	0.24	0.20
	33.33	0.48	0.25
.8	16.67	0.21	0.20
	25.00	0.31	0.20
	33.00	0.42	0.25
.9	18.75	0.21	0.20
	25.00	0.28	0.20
	33.33	0.37	0.25
1.0	20.83	0.21	0.20
	33.33	0.33	0.25
	50.00	0.50	0.50
1.1	25.00	0.23	0.20
	33.33	0.30	0.25
	50.00	0.45	0.50
1.2	25.00	0.21	0.20
	33.33	0.31	0.30
	50.00	0.42	0.50
1.3	27.08	0.21	0.20
	33.33	0.26	0.25
	54.17	0.42	0.30
1.4	29.17	0.21	0.20
	43.75	0.31	0.40
	58.33	0.42	0.58
1.5	33.33	0.22	0.25
	50.00	0.33	0.50
	75.00	0.50	0.70
2.0	50.00	0.25	0.48
	75.00	0.33	0.70
	100.00	0.50	0.80
3.0	75.00	0.25	0.70
	100.00	0.33	0.80
	150.00	0.50	0.90
4.0	100.00	0.25	0.80
	133.33	0.33	0.87
	200.00	0.50	1.00
5.0	125.00	0.25	0.85
	166.67	0.33	0.93
	250.00	0.50	1.10

100 mL Syringe

RATE µl/cm	DROP VOLUME (nl)	DROP PITCH (mm)	ON TIME (msec)
.2	4.17	.21	0.20
	8.33	.42	0.20
	12.5	.63	0.20
.3	4.17	.14	0.20
	8.33	.28	0.20
	12.5	.42	0.20
.4	8.33	.21	0.20
	12.5	.31	0.20
	16.7	.42	0.20
.5	12.5	.25	0.20
	16.67	.33	0.20
	25	.5	0.20
.6	16.66	.21	0.20
	25	.28	0.20
	33.33	.42	0.20
.7	16.66	.24	0.20
	25	.36	0.20
	33.33	.48	0.25
.8	16.67	.21	0.20
	25	.31	0.20
	33	.42	0.25
.9	25	.28	0.20
	37.5	.42	0.30
	50	.56	0.50
1.0	20.83	.21	0.20
	33.33	.33	0.25
	50	.5	0.50
1.1	25	.23	0.20
	33.33	.3	0.25
	50	.45	0.50
1.2	25.00	.21	0.20
	37.50	.31	0.30
	50.00	.42	0.50
1.3	33.33	.26	0.20
	50	.38	0.50
	54.17	.42	0.55
1.4	29.17	.21	0.20
	50	.36	0.50
	66.67	.48	0.67
1.5	33.33	.22	0.25
	50	.33	0.50
	75	.5	0.70
1.6	33.33	.21	0.25
	50	.31	0.50
	66.67	.42	0.70
1.8	37.5	.21	0.30
	50	.28	0.50
	75	.42	0.70
2.0	41.67	.21	0.40
	66.67	.33	0.67
	100	.5	0.80
3.0	66.67	.22	0.67
	100	.33	0.80
	150	.5	0.90
4.0	100	.25	0.80
	133.33	.33	0.87
	200	.5	1.00
5.0	125	.25	0.85
	166.6	.33	0.93
	250	.5	1.10

BioJet Quanti ä Line Dispensing Parameters: 250 – 500 mL Syringe, 0.375 to 10.0 mL/cm Dispense Rate

250 mL Syringe

RATE µl/cm	DROP VOLUME (nl)	DROP PITCH (mm)	ON TIME (msec)
.375	10.42	.28	0.20
	20.83	.56	0.20
	31.25	.83	0.25
.50	10.42	.21	0.20
	20.83	.42	0.20
	31.25	.63	0.25
.75	20.83	.28	0.20
	31.25	.42	0.25
	41.67	.56	0.40
1.00	20.83	.21	0.20
	31.25	.31	0.25
	41.67	.42	0.40
1.25	31.25	.28	0.25
	41.67	.37	0.40
	62.50	.56	0.66
1.50	41.67	.28	0.40
	62.50	.42	0.65
	83.33	.56	0.76
1.75	41.67	.24	0.40
	62.50	.36	0.65
	83.33	.48	0.76
2.00	62.50	.31	0.65
	83.33	.42	0.75
	125.00	.63	0.85
2.25	62.50	.28	0.70
	83.33	.37	0.74
	125.00	.56	0.86
2.50	83.33	.33	0.70
	104.17	.42	0.80
	125.00	.50	0.85
2.75	83.33	.33	0.75
	114.58	.42	0.80
	125.00	.50	0.85
3.00	93.75	.31	0.78
	125.00	.42	0.83
	166.67	.45	0.94
3.25	125.00	.38	0.85
	135.42	.42	0.88
	250.00	.77	1.11
3.50	125.00	.36	0.86
	166.67	.48	0.95
	250.00	.71	1.11
3.75	156.25	.42	0.92
	187.50	.50	0.98
	250.00	.67	1.11
4.00	166.67	.42	0.96
	250.00	.63	1.10
	333.33	.83	1.18
5.00	208.33	.42	1.00
	250.00	.50	1.10
	500.00	1.00	1.28
6.00	250.00	.42	1.08
	333.33	.56	1.17
	500.00	.83	1.28
8.00	333.33	.42	1.17
	500.00	.63	1.25
	666.67	.83	1.37
10.00	500.00	.50	1.30
	666.67	.67	1.33
	1000.00	1.00	3.00

500 mL Syringe

RATE µl/cm	DROP VOLUME (nl)	DROP PITCH (mm)	ON TIME (msec)
.375	20.83	.56	0.20
	41.67	1.11	0.40
	62.50	1.67	0.67
.50	20.83	.42	0.20
	41.67	.83	0.40
	62.50	1.12	0.65
.75	20.83	.28	0.20
	41.67	.56	0.40
	62.50	.83	0.65
1.00	20.83	.21	0.20
	41.67	.42	0.40
	62.50	.63	0.65
1.25	41.67	.33	0.40
	62.50	.50	0.65
	83.30	.67	0.75
1.50	62.50	.42	0.57
	83.33	.56	0.76
	125.00	.83	0.85
1.75	62.50	.36	0.65
	83.33	.48	0.75
	125.00	.71	0.86
2.00	62.50	.31	0.62
	83.33	.42	0.75
	125.00	.63	0.85
2.25	83.33	.37	0.74
	125.00	.56	0.86
	187.50	.83	0.98
2.50	83.33	.33	0.75
	125.00	.50	0.85
	166.67	.67	0.95
2.75	83.33	.30	0.76
	125.00	.45	0.85
	250.00	.91	1.11
3.00	125.00	.42	0.83
	166.67	.56	0.94
	250.00	.83	1.10
3.50	125.00	.36	0.86
	166.67	.48	0.95
	250.00	.71	1.10
4.00	166.67	.42	0.96
	250.00	.63	1.10
	333.33	.83	1.18
5.00	208.33	.42	1.00
	250.00	.50	1.10
	500.00	1.00	1.28
6.00	250.00	.42	1.08
	333.33	.56	1.17
	500.00	.83	1.28
8.00	333.33	.42	1.17
	500.00	.63	1.25
	666.67	.83	1.37
10.00	500.00	.50	1.30
	666.67	.67	1.33
	1000.00	1.00	3.00
15.00	625.00	.42	1.33
	1000.00	.67	3.00
20.00	1000.00	.50	3.00

BioJet Quanti ä Line Dispensing Parameters: 1.0 ml Syringe, 1.0 to 25.0 mL/cm Dispense Rate

1.0 ml Syringe							
RATE µl/cm	DROP VOLUME (nl)	DROP PITCH (mm)	ON TIME (msec)	RATE µl/cm	DROP VOLUME (nl)	DROP PITCH (mm)	ON TIME (msec)
1.00	41.67	0.42	0.40	4.00	166.67	0.42	0.96
	83.33	0.83	0.75		250.00	0.63	1.10
	125.00	1.25	0.85		333.33	0.83	1.18
1.25	41.67	0.33	0.40	4.50	187.50	0.42	1.00
	83.33	0.50	0.75		250.00	0.56	1.10
	125.00	1.00	0.86		375.00	0.83	1.18
1.50	83.33	0.56	0.76	5.00	208.33	0.42	1.00
	125.00	0.83	0.85		250.00	0.50	1.10
	166.67	1.11	0.96		500.00	1.00	1.22
1.75	83.33	0.48	0.75	6.00	250.00	0.42	1.08
	125.00	0.71	0.86		333.33	0.56	1.17
	250.00	1.43	1.11		500.00	0.83	1.28
2.00	83.33	0.42	0.75	7.00	250.00	0.36	1.11
	125.00	0.63	0.85		333.33	0.48	1.19
	166.67	0.83	0.93		500.00	0.71	1.29
2.25	83.33	0.37	0.74	8.00	333.33	0.42	1.17
	125.00	0.50	0.77		500.00	0.63	1.25
	250.00	1.11	1.11		666.67	0.83	1.37
2.50	83.30	0.33	0.73	10.00	500.00	0.50	1.30
	125.00	0.50	0.85		666.67	0.67	1.33
	166.67	0.67	0.95		1000.00	1.00	3.00
2.75	83.30	0.30	0.76	15.00	625.00	0.42	1.33
	125.00	0.45	0.85		1000.00	0.67	3.07
	250.00	0.90	1.11				
3.00	125.00	0.42	0.83	20.00	1000.00	0.50	3.00
	166.67	0.56	0.94				
	250.00	0.83	1.10				
3.50	125.00	0.36	0.86	25.00	1000.00	0.40	2.40
	166.67	0.48	0.95				
	250.00	0.71	1.10				

APPENDIX C – DISPENSER OPTIONAL COMPONENTS

LINE PRESENCE INSPECTION SYSTEM

The Line Presence Inspection (LPI) system is an option available for BioDot dispensing systems to detect the presence or absence of a dispensed line. This system utilizes fiber-optic technology that includes a reflectance sensor, fiber optic amplifier, and ink jet marker. The sensor inspects for absence of the dispensed line and marks the web material when the line/dot is missing.

The LPI system components should be installed with the help of a BioDot technician; proper placement of the fiber optic cables and accurate system calibration is required for the system to perform correctly. We have provided a very basic description of the system and the installation process below. Please contact BioDot **Support Service** with questions or to make adjustments to the LPI system.

Background

The LPI system consists of three main components, as shown in **Figure 11** on the following page.

Fiber Optic Wires (Transmit/Receive-Side Wire)

Transmit-Side Wire: A wire, identified by the presence of colored dots every ½ inch, which carries a fiber-optic beam of light to the web material
Receive-Side Wire: A solid black cable, which carries reflected light back to the system Amplifier

Amplifier

A sensor/amplifier, which monitors, measures and translates the reflected light intensity

Inkjet Marker

The InkJet Marker for the LPI system is a BioJet dispenser modified for the inspection marking function

Tools and Equipment

- Allen wrench set (standard)

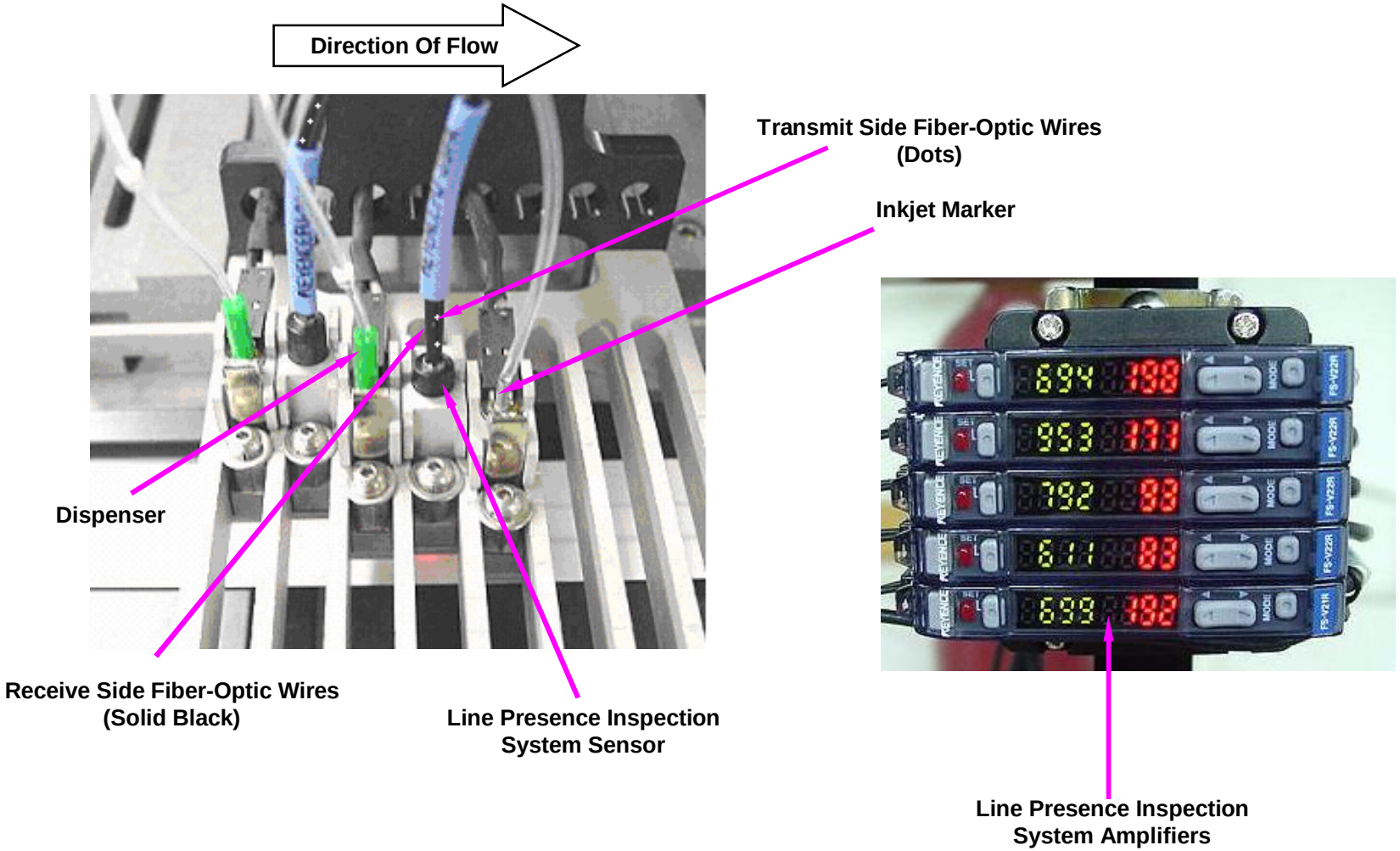

Direction Of Flow
Transmit Side Fiber-Optic Wires
(Dots)
Inkjet Marker
Dispenser
Receive Side Fiber-Optic Wires
(Solid Black)
Line Presence Inspection
System Sensor
Line Presence Inspection
System Amplifiers

Figure 11

Basic Installation

1. Ensure platform power is **OFF**.
2. Install your BioJet Dispenser(s) per Chapter Two - Dispenser Installation.

Note: If an LPI system is included in your dispensing system, your BioJet(s) will have been modified to accommodate the LPI system; a housing for the reflectance sensor and fiber optic wires should be located on the right side of each BioJet dispenser.

3. Adjust the height of each BioJet to its production height (dispensing height determined by your specific process specifications).

Note: The LPI system must be re-calibrated whenever dispensing height is adjusted to account for changes in the reflectance sensor depth of field.

4. Insert the fiber optic sensor on the right-hand side of each BioJet.
5. Ensure the observed dot of light is in sharp focus on the substrate (web). If the dot of light appears diffuse, adjust the height of the sensor within the slide housing using the small screw on the rear of the dispenser to loosen and then re-secure the sensor (**Figure 12**).
6. Orient the sensor so that the “receive side” (solid black) fiber optic wire is located downstream from the “transmit side” (dotted) fiber optic wire; the receive side of the sensor should be located on the inspection sensor side of each dispenser.
7. Calibrate the reflectance sensor. As calibration requires the exposure of the sensor to the same membrane when wet and when dry (membrane with a dispensed line vs. membrane with no dispensed line), this is most easily accomplished while the system is running:
   - While dispenser is running (a light can be observed on the front of the LPIS amplifier), press the “SET” button on the LPIS amplifier
   - Cover/catch the dispensed stream of fluid from the dispenser (so that fluid is no longer dispensed onto the web material) and press the “SET” button again.

Note: Refer to the Keyence Corporation product information for complete calibration instructions

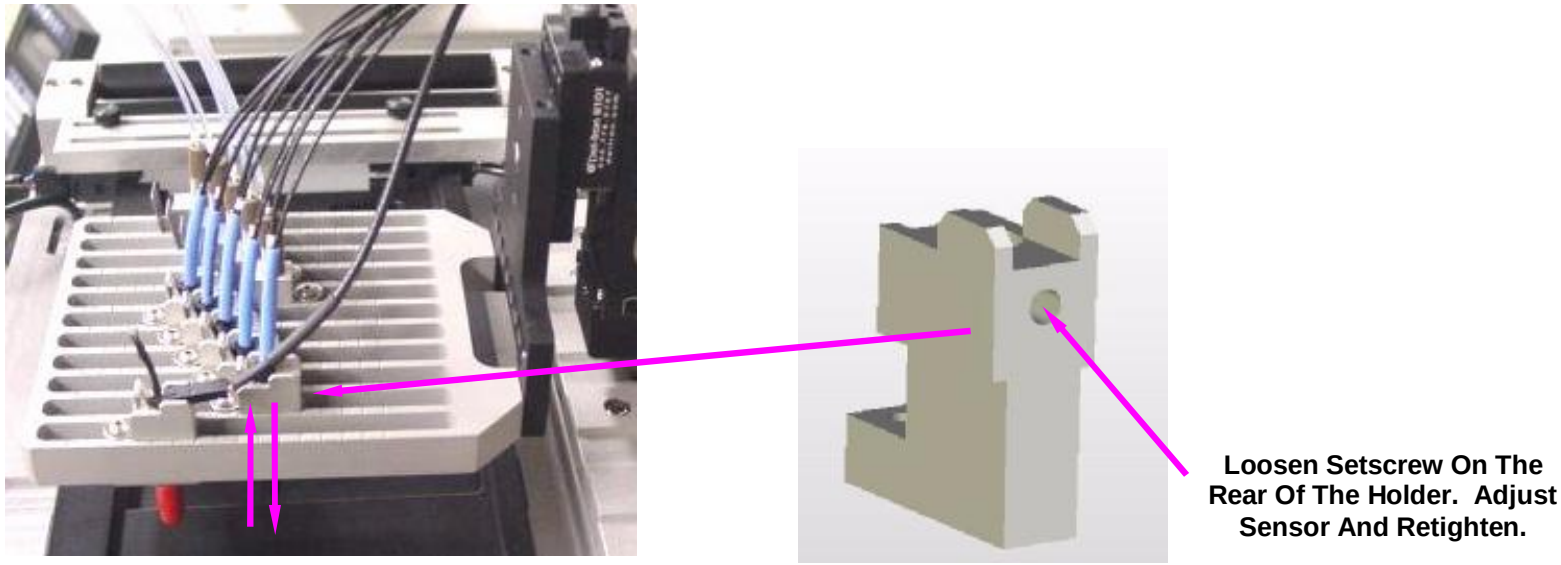


Figure 12

Contact Information

Support Service

If you encounter difficulty with the installation or of your unit, or if you are missing any component from your order, please contact Support Service at (949) 440 – 3685 or E-mail: support@biodot.com.

Please do not attempt to disassemble factory-assembled instruments or components without first speaking with a Support Service representative. Doing so may void your warranty. **Note**: A decontamination form must be filled out prior to the return of any dispenser or system. Please contact the e-mail address above for the correct form.

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